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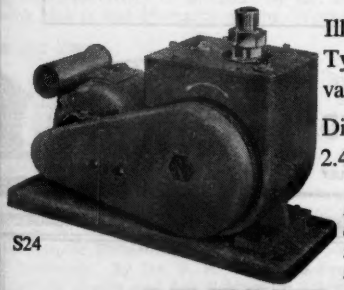

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AUTOMATION IN THE POST OFFICE: TECHNOLOGY AND HUMANISM

THE changes in the telephone service of Britain announced by the Postmaster-General in the House of Commons on November 13 and outlined more fully in a White Paper* published that afternoon have more than usual scientific and technical interest. Essentially they represent a dividend to the nation from an investment in technology. They provide also a striking example of the contribution which automation can bring to the improvement of conditions of everyday life and the way in which a service, hitherto expensive, comparatively restricted and sometimes slow, can be made cheap, almost universal and generally rapid. Perhaps even more important, they provide a noteworthy example of the way in which technical change such as automation should be handled; not merely its effect on the worker is discussed but also its dependence for full effect on his co-operation and understanding (see also p. 92 of this issue).

The White Paper explains that the Post Office is taking two big steps towards full telephone automation, and is pressing on quickly with a system in which all numbers are obtained automatically and charges for calls are recorded mechanically, thus giving better service at lower cost. The first step is to remove the system of charges designed for manual operation, which has hindered progress ever since the first automatic exchange was opened in 1912. Accordingly, from January 1, 1958, the present 6,000 exchanges, each with its own list of charges, will be reduced to about 600 charging units which will be called groups, and all exchanges in a group will have the same list of charges. In consequence, any subscriber will be able to call any other subscriber within his own group or an adjoining group (with few exceptions) for 3*d*., and existing equipment will be fully used for the first time. The 150 million calls a year now handled by operators will be dialled direct by subscribers, with very little additional equipment, and telephone costs will be cut by £2 million a year. Most trunk calls will also be cheaper under the new system; though about 3 per cent will be slightly dearer.

This step paves the way for the second step of full automation which is to follow later, commencing with the exchange at Bristol. Local, toll and trunk exchanges will be merged into one fully integrated automatic unit so that ultimately subscribers will be able to dial all calls. Charges will be recorded automatically on the subscriber's meter, eliminating all possibility of human error, and the minimum three-minute charge will be abolished. Ultimate savings in operating and accounting of £15 million a year are visualized, and by the end of 1958 it is expected that subscribers in Bristol will be able to dial about half the subscribers in Britain. Forty other towns will be similarly equipped by the end of 1960, and by 1970 three-quarters of all trunk calls in Britain will be dialled by subscribers.

The 'brain' of the new system is a robot telephone operator devised by Post Office research engineers and known as Group Routing and Charging Equipment, or 'Grace'. It will interpret the numbers dialled by subscribers, and route calls in the required direction, operate switches at intermediate telephone exchanges until the required exchange is reached, and then dial the number on that exchange. Some operators will still be required to provide such specialized services as personal calls, reverse charge calls, etc.; but the number of telephone operators will be greatly reduced during the next ten years and the automatic accounting already noted will also eliminate the work of 1,500 clerks.

The White Paper emphasizes that the biggest problems of this automation of the telephone system are not in the technical field; the human problems are much greater. Men and women are displaced, less staff is required and prospects of a career are jeopardized. The Post Office is well aware of the anxiety and hardship that could be caused in this way, and intends that this development shall be undertaken with the good-will of the staff. Full regard will be paid to the interests of those who have given long service, and to such added responsibilities as the staff may carry in future. These problems will be tackled by the Post Office and the trades unions together, and the Post Office trades unions have already declared their willingness to co-operate and to serve on working parties set up to consider the introduction of telephone automation and its problems.

These two steps together constitute the most sweeping and radical reform of the telephone service of Britain since the Post Office took over in 1912. Technically, they represent an advance of which Britain has a right to be proud, and a demonstration of how closely scientific and technical advance touches the everyday life of the community. They show that technical advance can—as it should—be shared with the community that pays for it, and perhaps the deepest interest of the White Paper even to the scientist and technologist is in the evidence it affords of the care which the Post Office has given to the social implications of automation. Lord Halsbury's arguments are seen here to be accepted and applied, and are in accord with the conclusions of the recent studies of PEP in this field.

Here, however, a remark which the Postmaster-General made should be noted. He pointed out that the development had been brought about not by new machinery but by the better use of existing machinery. Mr. Marples claimed categorically that

* Full Automation of the Telephone System. Pp. 14. (Cmnd. 303.) (London: H.M. Stationery Office, 1957.) 9*d*. net.

the benefits now offered to the nation have been made possible by the removal of administrative restrictive practices from the machinery or equipment already available and not being fully or efficiently used.

Mr. Marples may have been using the term 'restrictive' in the sense of 'obsolete', but the point is important. If Britain is to enjoy the full benefits which automation and other major technological developments like nuclear power offer, such developments must be operated under the appropriate conditions. The proper return on the vast investment involved will not be secured unless the equipment is operated at full load; and this is equally the case for investment in roads, railways and coal mines and also nuclear power.

It is true that, as the White Paper makes clear, in these developments in telecommunications there is little danger that the replacement of the drudgery of many by the skill of a relatively few technicians will involve large or sudden dismissals of staff; but the Post Office is taking no chances that normal wastage will not suffice to meet the situation and is adopting appropriate measures to deal with the human problems. Nor is it not simply in this respect that the whole attitude revealed in the White Paper is of outstanding interest. It was a main argument in the report by Prof. C. F. Carter and Prof. B. R. Williams on "Industry and Technical Progress" that lack of vision and enterprise and obsolete or restrictive practices both on the part of management and of trades unions in important sections of industry in Britain were preventing the adoption and exploitation of inventions and new discoveries. We have here a first-class illustration of the dividends in saving of labour and reduction of costs which a forward-looking attitude can pay in both social and commercial life, and also of the way in which problems of technological development should be approached.

Tribute has rightly been paid to the research workers whose achievements have made these advances possible. It is no less fitting that tribute should be paid to the vision and enterprise of the management that has broken through the practices and methods that have hitherto prevented Britain from enjoying the advantages those achievements offered; and also to the courage and responsibility of the trades unions concerned as well as of the management in tackling the human problems of adjustment with sympathy and openmindedness. The example which the Post Office is setting of the way in which to face the human problems of technological advance could prove one of the most important benefits the nation will reap from this striking development; this must be as significant as its demonstration that full use of technological advance can reduce prices and costs for the benefit of the whole economy. It could also assist to establish that confidence in the scientist and technologist and dispel the suggestion of mystery with which they are surrounded, thus making a further contribution to the effective use both of science and technology.

THE SEROLOGICAL APPROACH TO THE STUDY OF PLANT VIRUSES

Plant Virus Serology

By R. E. F. Matthews. Pp. xii+128+6 plates. (Cambridge: At the University Press, 1957.) 27*s.* 6*d.* net.

THE fact that plants do not apparently give rise to antibodies is liable to cause some confusion on the question as to how serology can have an application in the study of plant viruses. However, in 1928, Helen Purdy Beale demonstrated that the virus of tobacco mosaic was a good antigen; in other words, that the blood of a suitable animal, usually the rabbit, contains antibodies which react specifically in an observable way to the virus antigen when injected into it. This discovery provided a new and important tool for plant virus research, and its application is continually being developed and improved. By means of the serological reactions, latent virus infections can be readily demonstrated. This is of practical importance for several economically important crops, as in the building-up of virus-free stocks of potatoes and flower bulbs, for example. Furthermore, by means of this technique, relationships can be shown to exist between viruses which would otherwise never have been suspected of a close connexion. This, in turn, may throw light upon some problems which have long puzzled plant virologists. The ability to establish serological relationships between viruses gains an added importance in view of the unreliability of cross-protection tests which is only now being realized. Up to now all this information has been scattered widely throughout the plant virus literature, or given necessarily brief treatment in text-books of general plant virology, so that Dr. Matthews is to be congratulated on his book which, for the first time, gives a descriptive survey of plant virus serological methods together with practical instructions.

After a brief introduction, there is a description of the methods of preparing the viruses for injection into the rabbit and for collection of the antisera. The types of serological tests are next explained, followed by an account of the routine testing for virus infection. In routine work, the precipitation test is of particular value when large numbers of plants have to be examined for the presence of a latent virus infection; this is especially true in certification schemes for vegetatively reproduced plants. With modern developments this technique can now be applied directly in the field by persons without much training in the subject.

Chapter 5 gives a good description of the serological tests used for determining relationships among plant viruses. In Chapter 6, in his account of the precipitation reaction, the author includes some of his own original work. Certain plant virus nucleoproteins, which can be isolated in large quantities, are relatively homogeneous from the serological point of view, as compared with other protein antigens. The virus of turnip yellow mosaic is particularly suitable in this respect, and some aspects of the precipitation reaction are illustrated by new data obtained with this virus. These experiments have implications extending beyond the field of plant virus serology and should interest the general immunologist.

Chapter 7 deals with the antibody content of sera; this has not a general application to plant virus work, but i is useful on occasions. For example, titre

measurements on antisera showed that the 'top component' of turnip yellow mosaic virus, which has no nucleic acid, was much less efficient in stimulating antibody production than the 'bottom component' which is the nucleoprotein. In Chapter 8 the methods for estimating virus concentration are discussed, the precipitation reaction providing a rapid and convenient means towards this end. The specificity of the reaction allows virus to be estimated in the presence not only of plant impurities but also of unrelated viruses. In Chapter 9 the cross-absorption procedure is dealt with which can be used for estimating degrees of relationship between viruses, and in Chapters 10 and 11 experiments with mixtures of viruses and strains of viruses, and the causes of failure to obtain positive serological tests, are discussed. With regard to the last point, antisera have been prepared for about thirty plant viruses or groups of virus strains, but there are still 200 or more viruses to which serological methods have not yet been applied. In some cases repeated attempts to obtain antisera have resulted in failure; this may be in part due to lack of concentration of the virus, so that new methods of virus concentration may have to be devised. Then, of course, a large number of viruses are not mechanically transmissible and this greatly complicates the study of their serology.

This book is a valuable contribution to the study of plant viruses, and should be read by all plant virologists and by immunologists in general. The different procedures and their pitfalls are carefully and lucidly explained, and the illustrations and tables are excellent. The electron micrograph, in the frontispiece, shows dramatically how, in a mixture of viruses, the antiserum aggregates only the virus against which it was prepared. KENNETH M. SMITH

THEORY OF INSTRUMENTATION

Instrument Technology

By E. B. Jones. Vol. 2: Analysis Instruments. Pp. xi+208. 40*s*. Vol. 3: Telemetering and Automatic Control. Pp. x+198. 40*s*. (London: Butterworths Scientific Publications, 1956–57.)

IT is always a pleasure to read clear prose, and quite apart from the technical merits of these volumes, one is impressed by their lucidity. In these volumes, as in their predecessor, the author chooses as his audience the instrument mechanics of industry. Anyone interested in his subject can sympathize with the author in his task of selecting material and restricting explanations in a field where to-day's success may be to-morrow's museum exhibit. Mr. E. B. Jones is to be congratulated on providing a theoretical background to efficient instrument use and maintenance, even if it is possible to differ from the publisher's announcement which rather suggests the work is a maintenance guide. Obviously, nothing can replace the manufacturer's manual and still remain of general interest.

The second volume describes the principles and applications of measurements based on the composition of fluid streams or samples, and thus continues the treatment of pressure, level, and temperature measurement which was covered in Vol. 1. In this volume the very clear diagrams, and the short accounts of physical and chemical principles, are very attractive. The third volume attempts to show the application of automatic control to processes where variables are measured by the means examined in earlier volumes. In the discussion on telemetering, and especially of automatic control, all material appears to have been tested by the yardstick of usefulness, so that a well-grounded, but general, treatment results.

One can recommend this book for the training of instrument mechanics, since the level of knowledge that it will provide as adjuncts to the practical skills of installation, maintenance and 'trouble-shooting' can only result in a more intelligent use of instruments and automatic control devices. T. K. Ross

ELECTRONICS DIGEST

Handbook of Industrial Electronic Control Circuits

By John Markus and Vin Zeluff. Pp. xv+352. (London: McGraw-Hill Publishing Company, Ltd., 1956.) 66*s*.

The Cathode Ray Oscilloscope

Circuitry and Practical Applications. By J. Czech. Pp. xii+340. (Eindhoven: N. V. Philips' Gloeilampenfabrieken; London: Cleaver-Hume Press, Ltd., 1957.) 57*s*. 6*d*.

A CRITICAL survey of some aspect of technology is no mean task when undertaken by an individual author, if his book is to be reasonably up to date at the time that it appears. There are other and complementary ways of presenting accounts of current practice, either through collected digests of articles that have appeared in the technical periodicals, or from the collective experience of a company specializing in a particular field.

The book by Markus and Zeluff might be described as 'articles of lasting interest, skilfully digested' from the well-known journal *Electronics*. Some 350 articles that appeared during 1948–55 are included in a volume weighing 3 lb., a worth-while reduction from the 6 ft. shelf and 200 lb. of the original magazines.

Czech's book for users of the cathode ray oscilloscope is translated from the German, and is one of the extensive series of Philips's technical and scientific publications. Like many titles in the series, it is closely related to the experience and products of that Company.

While both books lack the critical approach to first principles so valuable to the advanced designers of equipment, they will be helpful to the wider circle of technicians interested in particular applications. The selection from *Electronics* has been classified under such headings as amplifier circuits, capacitance control, counting circuits, measuring circuits, metal detectors, motor control, oscillators, photoelectric controls, temperature control, timing, power supply and transistor circuits. A rather full index has been added, and provides a useful cross-reference between articles containing related material; the original reference is given in each case. As the title suggests, the emphasis is upon industrial control applications, written at the consistently practical level of the journal in which they appeared.

The user of cathode ray oscillographs will find the second book helpful, particularly because of the large number of oscillograms used as illustrations. It is not recommended as a 'first reader' on the subject, but is valuable for being written from a point of view different from the several English standard works. Its origin is most evident in the bibliography, and in the illustrations of instruments and circuits of one

particular manufacturer. There are excellent sections on general measuring technique in bridge circuits, for phase and frequency measurement, and for practical work on fluorescent lamps, camera shutters, flash bulbs and television receivers.

Neither book deals with the preferred functional circuit, a concept that would greatly simplify the pursuit of conventional circuits and reduce them to system-design, by building up an assembly of functional circuit 'bricks'.

Whether or not it is worth while using this approach to clear away retrospectively the profusion of detail in circuit design is in question for thermionic circuits, but it should be done for transistor circuits. The treatment of transistors in the first book extends only to the end of 1955, but is an excellent guide of what is to come, as semi-conductors are particularly suited to industrial applications. The second book looks backward rather than ahead in its field, and transistors are not mentioned, although they have made possible a significant future development, the miniature, portable, earth-free oscilloscope.

Denis L. Johnston

FLAME SPECTROSCOPY

The Spectroscopy of Flames

By Dr. A. G. Gaydon. Pp. ix+279+6 plates. (London: Chapman and Hall, Ltd., 1957.) 50*s*. net.

From the earliest times of recorded observations of matter, flame and fire have occupied a place of particular interest and importance, being so obviously remarkable in nature that they were frequently regarded as constituting a principle, or element. In the early nineteenth century it became clear that flames were generally to be associated with very rapid chemical reactions, usually of combustion, and attempts to understand them, on the basis of the characteristic light emitted from them, commenced. Serious attempts of this kind have had to await the development of the application of wave mechanics to spectroscopic data, which allowed of the analysis and identification of the spectra of short-lived radicals such as, for example, C_2, CH, OH, which appear in many common flames. The next step is to deduce the part played by such radicals in the physico-chemical processes occurring in flames, as part of a general scheme of elucidation of the detailed reactions of combustion.

A major part has been played in these studies in recent years by Dr. A. G. Gaydon, the author of the work under review. From time to time Dr. Gaydon has published monographs relating to the physics and chemistry of flames, which have been distinguished by their scope, their presentation of conflicting theories or points of view in a fair-minded way, and their ability to stimulate further work of importance. The present volume is no exception to this, and like the previous ones, is also most valuable for the large number of useful practical hints to workers in the field.

The book opens with a number of introductory chapters on methods of studying flame spectra, on techniques for obtaining special types of flames, such as diffusion and low-pressure flames, and on the elementary theory of atomic and molecular spectra. The last of these, while by no means supplying all the spectroscopic knowledge required by an intending worker in the field, is nevertheless a useful introduction.

The next three chapters deal, broadly, with accounts of the electronic spectra of hydrogen, carbon monoxide, and hydrocarbon flames with oxygen or air. They provide very complete descriptions of the observed features, with some discussion of whether the spectra show chemiluminescence (that is, non-thermal excitation), and of whether the concentrations of emitters are in excess of those to be expected for thermodynamic equilibrium. For example, a typically balanced account of the various views of processes of reaction in carbon monoxide flames is given. A further chapter discusses the analysis of spectra so as to obtain the effective translational, rotational, vibrational, etc., temperatures, understanding of which is required if the complicated distribution and exchange of energy between various types of molecule and degrees of freedom occurring in flames is ever to be solved in detail.

In further useful chapters the book deals with infra-red emission from flames (a rather neglected topic), the correlation of spectroscopic results with processes of reaction (including an account of carbon formation in flames), and industrial flames and engines. The book ends with an interesting account of various unusual flames, in which oxides of nitrogen, halogens, compounds of sulphur, etc., take part, and with a brief discussion of spectrophotometry of trace additives, which is itself beginning to throw light on the chemistry of flame reactions.

This is a most valuable book to all those working in any field which has points of contact with the study of rapid reactions of simple molecules. It may be that spectroscopic studies tend to emphasize the role of a small number of rather special free radicals and molecules, but it must be agreed, with the author, that "emission of light is the most distinctive property of a flame and must surely be capable of giving much information about what is happening".

T. M. Sugden

THE BIOLOGY OF AGEING

Ciba Foundation Colloquia on Ageing

Vol. 2: Ageing in Transient Tissues. Edited by G. E. W. Wolstenholme and Elaine C. P. Millar. Pp. xi+263. 36*s*. net. Vol. 3: Methodology of the Study of Ageing. Edited by G. E. W. Wolstenholme and Cecilia M. O'Connor. Pp. x+202. 32*s*. 6*d*. net. (London: J. and A. Churchill, Ltd., 1956–57.)

The Biology of Ageing

Edited by W. B. Yapp and G. H. Bourne. (Symposia of the Institute of Biology, No. 6.) Pp. xiv+128. (London: Institute of Biology, 1957.) 25*s*.

Reports of the various symposia and colloquia, especially on endocrinological subjects, which have been organized by the Ciba Foundation, are by now widely known and appreciated. A series of colloquia on ageing is one of the more recent activities of the Foundation, and Volumes 2 and 3 provide the material which was presented at two meetings of gerontologists in July 1955 and July 1956.

Volume 2, which is devoted to a study of the ageing of component tissues of the body whose span of life is shorter than that of the whole animal, might at first glance be mistaken for one in the series of endocrinological symposia; for many of the papers deal with the growth and development of tissues concerned with reproductive processes in a fairly narrow endocrinological context. Thus, among

various aspects of ovarian function, Sir Solly Zuckerman defends the thesis that oogenesis is a process that comes to an end at, or about the time of, birth, and deals critically with recent observations which purport to resuscitate the other view that neoformation continues into adult life, while Dr. Williams and Dr. Rowlands discuss the life, growth and fate of the large ovarian follicles and the corpus luteum respectively. Other mainly endocrinological contributions describe experiments concerned with such diverse subjects as the tissue culture of fœtal reproductive tracts and the study of the human testis with the electron microscope. The placenta is an excellent example of a transient tissue, and a further group of papers describe the morphological and biochemical changes in the organ during pregnancy. Dr. Villee thought that there was no evidence for any senile change in function which could be used to explain the onset of labour, and felt that the placenta was still quite active metabolically at the end of its life. A comparable conclusion came from Prof. Huggett, "that there is evidence that its 'efficiency', certainly for some functions, is increased in its old age; in fact, it might be said to be abruptly expelled in the prime of life".

Other papers by Dr. Mollison and Dr. Lovelock discuss what happens to the red blood cells to bring their life to such a rapid end, and what could be done to prolong their survival in storage. Age changes in the sweat glands of the human female, the factors controlling growth of the antlers in deer, and finally a botanical paper on the metabolism of senescent leaves, are titles which give some indication that, on this occasion, the limits of the definition of ageing were very widely stretched, perhaps to the extent of causing a lack of cohesion in the contents of the volume.

Contributors to the third colloquium on the "Methodology of the Study of Ageing" related their papers more closely to a single general theme. The study of ageing is of such relatively recent scientific respectability that workers in the field are acutely conscious of the need to agree on the basic definitions of their subject and on the limitations of various methods for studying the problem. At present they are more aware of the needs than confident that they have found solutions. It is clear that no one was sure about the level of organization at which ageing can be studied most profitably. Some thought that the comparative approach in studying whole populations had been badly neglected, whereas others discussed the ways in which ageing in separate organ systems or in individual cells might provide the important clues. Clinicians at the meeting were perhaps unnecessarily humble in believing that studies on human beings were less likely to be valuable than those of experimental workers on the mouse or the hamster.

The latter part of Volume 3 is taken up with a discussion of the psychological aspects of ageing and is notable for an excellent account by Welford of the problems which face those who want to understand the reasons why the work performance of human beings changes as they get older. Much of what he had to say about the design of experimental studies in psychological problems is very relevant to the design of experiments on animals for other gerontological purposes.

"The Biology of Ageing" summarizes the contributions to a symposium, organized by the Institute of Biology, which was intended for a much wider audience than is to be found at the Ciba Foundation. The papers cover all aspects of ageing from the demographic aspects in human populations to ageing in bacteria and higher plants. Several of the authors whose papers appear in the Ciba Colloquia are also represented in this volume, and some of them say little that they have not said elsewhere. The volume does, however, bring together contributions which should satisfy the many non-specialists who want to know how the subject is developing without wishing to immerse themselves in the details of experimental work which are to be found in the Ciba Colloquia.

P. L. KROHN

CHEMISTRY AND LIFE

A Symposium on the Chemical Basis of Heredity

Edited by William D. McElroy and Bentley Glass. (Sponsored by the McCollum-Pratt Institute of the Johns Hopkins University, with support from the Atomic Energy Commission.) Pp. xiv+848. (Baltimore, Md.: The Johns Hopkins Press; London: Oxford University Press, 1957.) £5 net.

THIS book describes in great detail the remarkable discussion of the chemical basis of heredity held in 1956 at the Johns Hopkins Institute. Almost every aspect of the problem of heredity was discussed and the very wide extent of the matters under survey is shown by the fact that Dr. Bentley Glass occupies no less than 77 pages in his summary of the whole symposium.

Original work is described in eight chapters which are subdivided into sections with the various discussions within the sections. The chapters concern "Cellular Units of Heredity", "The Role of the Nucleus", "Nucleic Acids and Associated Structures in Cell Division and Protein Synthesis", "Nucleic Acids —as Transforming Agents", "Viruses as Bearers of Heritable Characteristics", "Nucleic Acids—Chemical Composition and Structure", "Synthesis of Nucleotides and Nucleic Acids" and "Mechanism of Duplication". In this book all the papers are written with great clarity and are frequently illustrated by photographs and diagrams. For special mention one would point to the discussions on the nucleus and on the synthesis of proteins, the various aspects of nucleic acids as transforming agents, where the most astonishing discoveries are being made, and the outstanding work of Fraenkel-Conrat and his colleagues on the nature of viruses reconstituted from protein and nucleic acids. In addition there are discussions on the structure of deoxyribonucleic acid, particularly the Crick–Watson double helix, the polynucleotide biosynthesis of Ochoa and the biosynthesis of nucleic acids in some microbial systems. Delbruck's mechanism of deoxyribonucleic acid replication and the molecular basis of genetic recombination in phage are both remarkably good chapters.

The discussions of the various papers have been well recorded and form some of the most interesting reading in the book. From this conference it is apparent how much structural and physical chemistry are adding to knowledge of the biology of genes, chromosomes and studies in heredity generally.

The organizers of the symposium are to be congratulated on getting together such a wealth of talent; and the authors have done an excellent job in interpreting their ideas and latest discoveries. Every geneticist and biochemist will need to possess this book.

M. STACEY

THE FARM LIVESTOCK RESEARCH CENTRE OF THE ANIMAL HEALTH TRUST

By Dr. W. R. WOOLDRIDGE
Scientific Director of the Trust

IN opening the new Farm Livestock Research Centre of the Animal Health Trust at Stock in Essex on Friday, December 6, H.R.H. Prince Philip, the Duke of Edinburgh, said: "There are three reasons why I am very pleased and delighted to be able to visit, open and look round these Animal Health Trust Laboratories. As you have just heard, I do not believe in half measures, and so I am president of the Royal Agricultural Society, president of the British Dairy Farmers Association and president of the Smithfield Show, and all of them are vitally interested in the health of farm animals. It also gives me an opportunity in the capacity of president of these three organizations and also in my personal capacity to express our admiration and appreciation of all the work that is done by the Animal Health Trust in all their laboratories in different parts of the country for the domestic animals of this country and, of course, animals all over the world.

"The third reason is because I am personally quite interested in farming and livestock generally and also because I am fascinated by all kinds of research. I like to see these ingenious techniques that are used to solve rather complicated problems. I like the atmosphere in a research establishment—the pleasure and excitement whenever some useful bit of work has been achieved after a great deal of hard work. I believe that in this world where we think that we know everything and we think that we can do everything it is sometimes good for the soul to be reminded how much we do not know, and one of the best places to find out is in a research laboratory.

"In this place there will be plenty to do—there is no doubt about that—for the prevention of disease and sickness and suffering in animals and also to help agriculture in the commercial sense. Disease in farm livestock is supposed to cost farmers something like £70 million a year, and so any investigation into disease and methods of cure and prevention is of the first importance. But there is an enormous gap between actual sickness on one hand and what one might describe as vigorous health on the other. There are all sorts of things in that gap. Infant mortality among human beings is something like 2 per cent; in farm livestock it is anything between 15 and 20 per cent. That is not an actual disease, but it is also not good health. Then there is infertility, that is not necessarily a disease, but there is something not exactly right, and in farm livestock in this country it is becoming rather a problem. A great many farm animals are becoming worn out sooner than they ought to—their productive life is not as long as it used to be. We do not know why strange things happen when we change the diet. We know some of the things that happen, but we do not know other things that happen. We do not know how the treatment of feeding stuffs with different things will affect the people who eat the animal products. I hope these and many other things will be investigated that are in the capable hands of Dr. Sellers and his helpers in these laboratories. I am quite sure they will soon be responsible for many, I hope, fruitful developments.

"I would also like to add my appreciation of the work and support that is being given to this effort by the Boreham Institute and their generosity, and I hope for their sakes also we may see some fruitful developments".

This Centre is one of four established by the Animal Health Trust—the others being organized also on a species basis and devoting their energies, respectively, to horses, dogs (and cats) and poultry. The Equine and Canine Centres are at Newmarket, and the Poultry Research Station, which is now an independent entity jointly supported by the Agri-

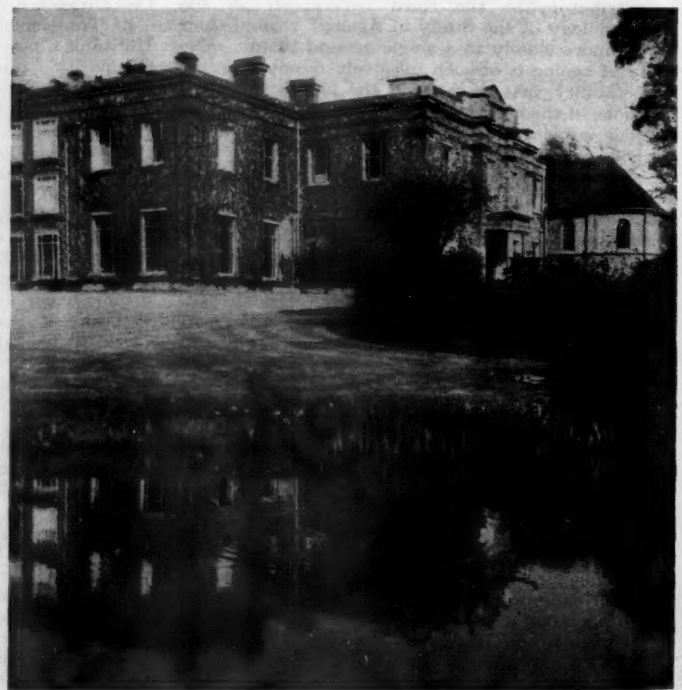

Fig. 1. Lilystone Hall, Farm Livestock Research Centre, Stock

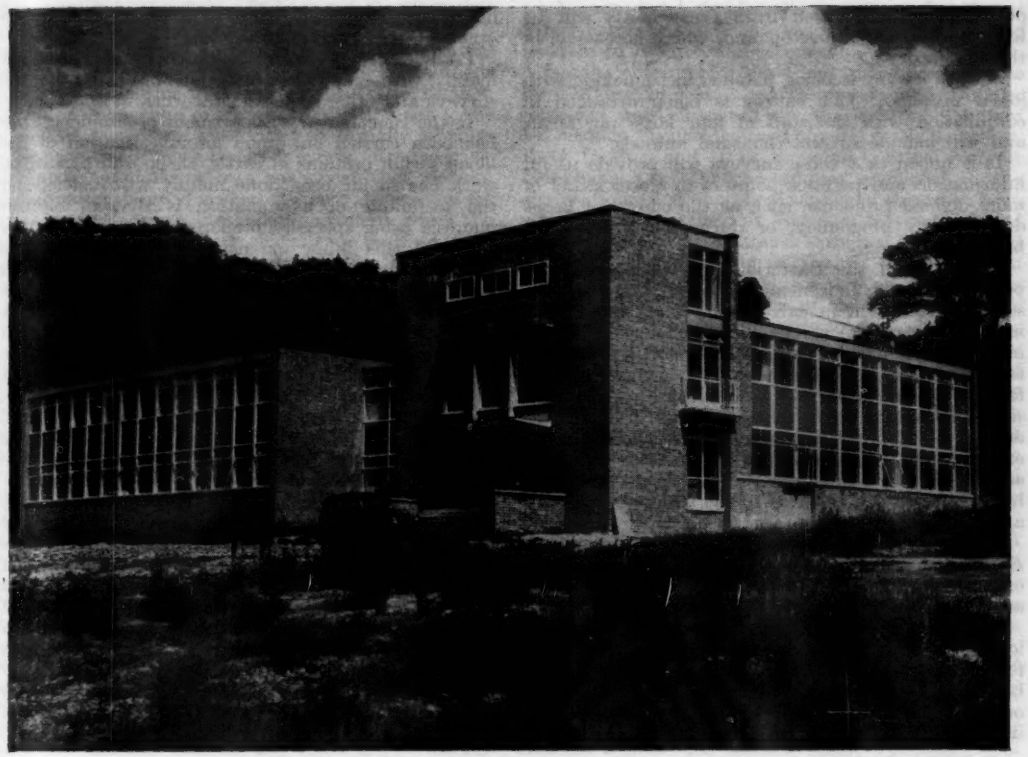

Fig. 2. New Laboratory Buildings of the Farm Livestock Research Centre

cultural Research Council and the Animal Health Trust, is at Houghton, Huntingdonshire.

The Trust is a unique organization, in that it is entirely independent; it was founded at the end of 1942 and has maintained itself by voluntary subscriptions from owners of animals, from the general public and from organizations interested in animals. Up to date it has raised more than £1 million, which has been spent in carrying out its aims, namely to assist in the field of veterinary education and to promote researches into disease of animals and the relief of animal suffering. On the educational side it assists needy veterinary students of merit to complete their studies at the universities and makes postgraduate awards to those desiring to enter research or academic careers. It has awarded more than one hundred undergraduate studentships and more than eighty postgraduate scholarships and fellowships at a total cost of more than £100,000.

The Farm Livestock Research Centre, like the other stations, has an entity of its own, although they all come under the ultimate supervision of the scientific director of the Trust, who is advised by a Scientific Advisory Committee. Dr. K. C. Sellers is the director at Stock. The scientific staff at the moment is small, including Dr. Williams Smith as bacteriologist; Mr. G. Skulski, pathologist; Mr. A. L. Ogden, in charge of field surveys; Mr. C. G. Ashton, biochemist.

The new laboratories, which will allow for some increase in the scientific staff, have been erected by the Boreham Trust, which, in addition to paying for these new buildings, has let the whole of the Lilystone Hall Estate, comprising a mansion and 37 acres, to the Animal Health Trust at a peppercorn rent (Figs. 1 and 2). The animal houses, few in number at the moment but allowing plenty of room for later development, are of a type which will permit them to be adapted fairly readily for use with different species of animals.

As with the other research centres of the Trust, the scientific staff maintains effective liaison with the farmer or other animal owner, as it is part of the policy of the Trust to employ scientists who have in addition to their own specialist experience a reasonable knowledge of the management and husbandry methods used with the species they are studying. A Livestock Advisory Committee composed of representatives of the major livestock organizations in Britain advises the director.

One of the major developments at this Centre is the carrying out of surveys in connexion with various diseases of livestock. Dr. Sellers has himself carried out a survey in east Yorkshire on the diseases of sheep, paying particular attention to losses in pregnant ewes. This survey is being continued and followed up in the laboratory.

Mr. Ogden is making a thorough survey of bovine infertility in the eastern counties in co-operation with the Milk Marketing Board. He is in close touch with the Board's progeny-testing schemes and artificial-insemination centres, and the animals, chosen at random, under his direct supervision include 3,000–4,000 cattle from some two hundred herds. Wherever

possible, animals culled from these herds will be followed up in the abattoir and, where necessary, in the laboratory.

A third survey is being planned in connexion with losses in pigs. This survey is being arranged in conjunction with the staff of four large pig farms and will include several thousand animals.

It is hoped that these surveys will provide useful information and perhaps pointers to closer study of more defined problems, such as the causes of losses during early pregnancy, or during early life from birth to weaning.

The work of the Bacteriology Department is at present largely concentrated on a study of the scouring condition in calves and young pigs. The investigations have revealed that bacteria involved in the scouring condition may develop a resistance to antibiotics used in general management and as feeding additives—a fact which can have a considerable bearing upon the therapeutic use of these drugs. A technique has been devised whereby, from examination of dung samples sent in from farms, an assessment can be made within a period of only six hours, and advice given as to the best treatment for affected animals.

This work has so far been carried out mainly with *Bact. coli*, but it is being extended to other pathogenic organisms of the alimentary tract, including certain anaerobes.

Work is also continuing on Johne's disease. Following earlier work whereby a medium was devised for the more rapid culture of the Johne's disease bacillus, the presence of these microbes in various organs and tissues of the body is being examined, and useful information is being obtained which may throw light upon the route and method by which the organism gains access to the body.

Pathological work of the Centre is concerned mainly with examining material obtained from the surveys and other experimental work at the station.

In the Biochemistry Department preliminary work has been carried out upon an investigation of the blood serum proteins of cattle, sheep and pigs. The work has so far been done mainly with cattle, and the technique of examination is that of electrophoresis using specially prepared starch gels. As a result of this fairly extensive examination, it has been shown that the serum proteins of cattle fall into five patterns when examined in this way, and it has further been demonstrated that these patterns have a hereditary basis. The work is being extended to see whether, in addition, the patterns are linked in any way with such economic factors as the butter-fat or the solids-not-fat content of milk. Theoretically, it would appear that there should be a sixth pattern, and as no evidence of this has been obtained it is deduced that the mating which would give rise to this pattern is also linked with a lethal factor.

In the future it is hoped to increase the scientific staff and investigate other problems of importance to livestock farming. Certain *ad hoc* problems are already being examined, such as the treatment of bovine ringworm and the part played by iodine and vitamin A in the growth and possible disease of piglets. It is not intended, however, that this Station shall become a huge one, although there is still room for improvement which will, of course, in an organization such as the Animal Health Trust, depend upon the support it receives from livestock owners and other bodies interested in agriculture.

SCIENTIFIC OBSERVATIONS OF THE ARTIFICIAL EARTH SATELLITES AND THEIR ANALYSIS

THE advent of the Russian Earth satellites occurred so suddenly that few preparations had been made for observing them. Until July 1957, no information was available about the frequencies which were to be employed in their radio beacons. The chosen American frequency of 108 Mc./s. had been known for some time, but it was also known that the inclination of the proposed American orbits would not exceed 40°, so that it would be very difficult to make observations from stations in Britain. Considerable interest was therefore displayed when the Russians announced that their satellites would circulate in orbits at inclinations near 60°, though no detailed preparations for observation were made before the conference on rockets and satellites held under the auspices of the International Geophysical Year in Washington during September 30–October 5. It was known that a Russian delegation would attend, and it was hoped that further useful details would be forthcoming from them. In the event, the announcement of the successful launching of the first Earth satellite came during the last evening of the conference—it was announced to the conference delegates by Dr. L. V. Berkner, the American organizer of the conference, at a cocktail party, given by the Russian delegates in the Soviet Embassy in Washington.

Methods for radio, visual and radar tracking were hastily improvized. In Britain a remarkable amount of scientific work has been carried out by a great number of observers in universities and Government departments as well as by amateurs. Because of the wide range of techniques employed and the need for co-ordination of effort, a discussion was arranged by the Royal Society and was held on November 29. Papers were presented by representatives of the Cavendish and Mullard Laboratories at the University of Cambridge, the Jodrell Bank Station of the University of Manchester, the Royal Aircraft and Royal Radar Establishments, the B.B.C. and Post Office Engineering Departments, the Nautical Almanac Office, the Admiralty Signals and Radar Establishments and the Radio Research Station. Dr. J. Heywood also contributed to the discussion an account of the work done by the British Astronomical Association and the Radio Society of Great Britain. In addition to these British contributions, there was special interest in a paper presented by Dr. L. Jacchia of the Smithsonian Observatory at Cambridge, Massachusetts, on the work done in the United States on the computation of orbits for the satellites.

Much experience has been gained from the work on the first two satellites which will be of great value for

future work in this field. It is now quite clear that radio tracking, while not suitable for very precise determination of satellite orbits, is quite essential as an adjunct to the use of more precise methods involving optical or radar techniques. The Russian choice of frequencies of 20 and 40 Mc./s., much lower than the American, was criticized initially because of the relatively large tracking errors introduced by the ionosphere. Experience has shown that, in fact, the accuracy is good enough to provide predictions of value for optical and radar observers, while the sensitivity to ionospheric effects can be used with great advantage for studying the structure of the ionosphere. However, it is important that the precise methods be brought to bear before failure of the radio allows the satellite to be lost.

It has been established also that optical observation of a satellite as small as the first one is a very difficult matter. This satellite seems rarely to be brighter than a sixth-magnitude star. Very good seeing conditions are required in order to observe it during the brief intervals at dawn and twilight when it is illuminated by the Sun. It was fortunate, therefore, that the rocket case which accompanied the first satellite was a very bright object when illuminated, equivalent to a star of magnitude − 1.

Because of the difficulty of optical tracking and the failure of the batteries supplying the power for the radio beacons (after three weeks for the first satellite and one week for the second), special emphasis was placed on the importance of radar tracking. The world's largest radio telescope at Jodrell Bank and also the 45-ft. diameter instrument at the Royal Radar Establishment were used with much success. In both cases the equipment was built primarily for radio-astronomical studies, and rapid improvization was necessary to fit them with reflexion radar.

The potentialities of the radar methods are considerable, and it is fortunate that two telescopes are available with such differing characteristics. The smaller, 3,000 Mc./s. telescope should be capable of detecting the small satellite at a range of 1,000 miles, and the short pulse-length (5 μsec.) gives the range to a precision of 1 km. The angular accuracy is better than $\frac{1}{2}°$, and the short-wave beam is barely affected by ionospheric refraction. Further, spurious reflexions from meteor trails, which are a major annoyance in using pulses of lower frequency, are greatly reduced. However, the narrow beam width, $\frac{1}{2}°$, makes searching for the satellite a long process unless its position is already fairly well known, and in fact so far the small satellite has not been observed with this instrument. Here the larger telescope, operating on frequencies of 36 and 120 Mc./s., had the advantage. Though the range on 36 Mc./s. was considerably less than that of the 45-ft. instrument, the beam width of 4° semi-angle was a great asset when searching. Radar is also of special value in the last stages of a satellite's life, and the interesting possibilities should the satellite leave a meteor type of ionization trail were emphasized.

The radar methods provide a means of determining the reflecting area of the satellite. For the rocket, a figure of 10 m.² is obtained, while for the sphere it is about $\frac{1}{4}$ m.². This is consistent with rocket dimensions of about 4 ft. diameter and 25 ft. long, but there appears to be some discrepancy between the drag to be expected for such a body randomly orientated and the drag actually observed. The large size of the rocket body is supported by the visual observations, and it has been suggested that the low drag is to be accounted for by the presence of sufficient aerodynamic stability to keep the rocket moving head-on to its direction of motion.

Results obtained for the orbits of the first satellite by the use of radio interferometers and Doppler recorders were described by Mr. M. Ryle (Mullard Laboratory, Cambridge) and Messrs. A. N. Beresford, E. G. C. Burt and D. G. King-Hele (Royal Aircraft Establishment). The techniques employed in the observational and analytical aspects of this work have already been described in *Nature* of November 2 and 9. The accuracy attainable is sufficient to detect and check the major effects of the Earth's equatorial bulge. Normally this produces two principal effects —a precession of the plane of the orbit about the Earth's axis in a sense opposite to that of revolution of the satellite, and a rotation of the major axis in the orbital plane. At the inclinations (nearly 65°) of the Russian Earth satellites, the second effect is very nearly zero—it vanishes for orbits with inclination 63·4°. The predicted rate of precession of the orbital plane about the Earth's axis is 3·2°, which is close to the values 3·18° and 3·17° found by the Royal Aircraft Establishment and Mullard Laboratory observers, respectively.

The effect of air resistance is to reduce the period of revolution of a satellite at a gradually increasing rate. In principle, it is possible to derive information from observations of this kind about the air density and temperature at different levels of the atmosphere through which the satellites pass. Actually, an additional complication arises from the existence of an electrical drag effect due to the effect of charging up of the satellite in its passage through the ionosphere. The fact that no less than three objects of different aspect—the satellite itself, the rocket-case and the nose-cone—were put into orbit by the first launching has been of value in studying drag. Mr. Ryle explained how it was possible, from a combination of the radio observations of the satellite with the optical and radar observations of the rocket case, to make a calibration to determine the effective drag cross-section of the latter, assuming it to be spherical. Thus in the first week or so the rate of change of period per revolution was 1·84 times greater for the rocket case than for the satellite. It seems that the satellite separated from the rocket case at a relative velocity of 186 cm./s. in a direction opposite to the orbiting motion. It thus fell to a lower altitude and commenced orbiting more rapidly, very soon overtaking the case. Soon, however, the greater drag on the case reduced its altitude and caused it once again to overtake the satellite.

Probably the most prominent feature of the discussion was the clear need for accurate orbit data. The radio methods can give apparent position with considerable precision. Thus the interferometers give apparent direction to 1 minute of arc, while the Doppler method gives the time of nearest approach (electrical) to a few milliseconds. That these results are very far from giving the true position can be judged from the fact that the time of nearest approach given by the 40 Mc./s. signal may differ by many seconds from the time given by the 20 Mc./s. signal, and signals may be received from beyond the horizon.

The discouragement of orbit-computing with data containing some material of doubtful reliability was clear from Mr. D. H. Sadler's account of the excellent work done at the Nautical Almanac Office. At Herstmonceux every observable transit had been observed. To be useful, position data should be accurate to

1/10° and 1/10 sec. time. Ten times this precision is required to derive useful information from the periodic deviation from ellipticity caused by terrestrial oblations, and for geodetic purposes another order of magnitude in precision is necessary.

Dr. Jacchia described the computational procedures used at the Smithsonian Institution, where they have the large *IBM* 704 type of electronic computer. He had ten good optical observations of the sphere and seven of the nose cone. The following expressions were given for the position of the components of the first satellite at time t; α is the right ascension of the ascending node and t_n the time of nth crossing. Time is in year days (that is, Jan. 1, 1957, $t = 0$; Oct. 7, $t = 280$).

Sputnik 1:

$$\alpha = 334{\cdot}3° - 3{\cdot}058°\,(t-280) - 0{\cdot}00408°(t-280)^2$$

Rocket:

$$t_n = 282{\cdot}82058 + 0{\cdot}0686222n - 1{\cdot}47721\,\exp 0{\cdot}00134n - 1{\cdot}769 \times 10^{-5}\exp 0{\cdot}0102n$$

Sphere:

$$t_n = 277{\cdot}87138(\pm 0{\cdot}00025) + 0{\cdot}0668120(\pm 0{\cdot}0000036)n - 8{\cdot}84\,(\pm 0{\cdot}12) \times 10^{-7}n^2$$

Nose cone:

$$t_n = 277{\cdot}87224\,(\pm 0{\cdot}00013) + 0{\cdot}0667072(\pm 0{\cdot}0000023)n - 6{\cdot}007\,(\pm 0{\cdot}079) \times 10^{-7}n^2$$

The right ascension of the ascending node for *Sputnik* 2 was given as:

$$\alpha = 306{\cdot}7° - 3{\cdot}18°\,(t - 289)$$

The probable errors for the present position of the components emphasize the necessity of obtaining accurate data while the radio transmitter is still operative. If inadequate precision is attained during this phase, the satellite may be lost, as has occurred with the sphere, and optical and radar equipment may have much difficulty in finding it. At the time of the conference, a few kinetheodolite observations had been made in Australia, and at the Royal Aircraft Establishment it is intended soon to use kinetheodolites to give a precision of 1 msec. in time and 30 sec. of arc; but on the whole, in Great Britain especially, there has been a paucity of precise data.

The great benefit to ionospheric research of a pair of radio transmitters circulating within the *F*-layers was very evident. Much data have been accumulated, though of necessity interpretation lags behind. Indeed, inadequate orbit figures may reduce the value of some of the radio data. From the first, the B.B.C. carried out precise monitoring of all the telemetry and radio beacon signals. Several false starts to the Doppler frequency–time curves were noticed, which suggested $2\frac{1}{2}$, $1\frac{1}{2}$ and $\frac{1}{2}$ hop-modes of propagation by ionospheric reflexion.

A somewhat similar phenomenon had been observed by the Post Office Engineering Department, a considerable portion of a Doppler frequency drop having occurred while the satellite was still 2,000 miles away. This was tentatively attributed to reflexion from some patch of intense ionization near to the satellite.

Using a wide-aperture high-frequency direction finder, the Admiralty Signals Establishment observed the satellite over global distances at night. Propagation, it was suggested, might be by a leaky waveguide mode in the ionosphere, or by a multihop system. Another ionospheric effect was evidenced in the widespread observation that the Doppler frequency appeared to rise again before the signal finally disappeared. The influence of the ionosphere was also evident in the observations made of apparent bearing and elevation at 20 and 40 Mc./s. at the Radio Research Station. It was once more evident that, before these efforts can be interpreted in detail, more accurate data on time, bearing and elevation are required.

The first satellite's transmitters were keyed on both frequencies at rates varying from 108 to 180/min. The mark-to-space ratio varied considerably, and on one or two transits a curious repetitive variation in transmitter-frequency occurred during the pulse. At times also the signals from one transmitter were received at reduced strength during the transmission of the other frequency. Several measurements of field-strength gave the beacon power as a little more than 1 watt.

A variety of types of signal fading were noticed by many observers, including those using reflexion radar. A comparison of the behaviour of signals in aerials polarized at right angles and of the relative frequency of the fading on the two beacon frequencies makes it possible to distinguish between the effect of the satellite rotation, the Faraday effect and scintillation due to ionospheric irregularities. It appears that the first satellite was rotating at about 7 rev./min.

The determination of ionospheric density by Doppler measurements, by the Faraday rotation of the plane of polarization and by refraction as given by the interferometer was discussed by Dr. K. Weekes. The Faraday effect would appear to be the most promising method, though results obtained in this way so far seem to give values for electron number per unit area column in excess of those obtained by conventional radio probing.

H. S. W. Massey
R. L. F. Boyd

THE GRASS COVER OF AFRICA

By R. O. WHYTE and J. M. RATTRAY
Agriculture Division, Food and Agriculture Organization of the United Nations, Rome

In those regions of Africa in which tsetse fly is not a limiting factor, domestic livestock play an important part in the economy of both European and African agriculture, and their grazing is provided almost entirely by the natural vegetation. It is therefore essential to have information on the ecological status and behaviour of that vegetation and particularly of the grass components, as a basis for what has come to be called the ecological management of grassland, in relation to its most efficient utilization and optimal productivity.

There are three main stages of the mapping of grazing lands and grass associations: (1) a physiognomic map of vegetation made by plant geographers; (2) a generalized map of the grass associations; (3) detailed studies of botanical composition and suc-

cession made on individual grass associations and on limited areas.

The latest map of the first type is that prepared by A.E.T.F.A.T. (Association pour l'Étude Taxonomique de la Flore d'Afrique), which recognizes, along with various types of forest and woodland, the geographical distribution of savannah, woodland savannah, xerophilous woodland, semi-desert scrub and grassland, all of which may represent a grazing resource of varying importance. The grassland ecologist and agronomist then knows where the grasslands are; but he must obtain further information regarding the botanical composition and ecological status and behaviour of the grass associations before he can make recommendations regarding their management.

The Food and Agriculture Organization of the United Nations has as a long-term objective the mapping of the grazing resources of the underdeveloped regions of the world on some basis which will be of value to those concerned with the improvement of grassland management and of the livestock industries which depend on them. The grazing and other resources of northern Australia are already being dealt with by Land Research and Regional Survey of the Commonwealth Scientific and Industrial Research Organization using the comprehensive survey technique involving team-work on geomorphology, geology, soils, climate, vegetation and land utilization, and leading to the recognition of land systems.

As a result of recommendations made by R. O. Whyte while acting as grassland adviser to the Government of India, a five-year reconnaissance survey of the grasslands was begun in 1954, and has already covered more than half the country. In a forest environment where climax grassland comparable with steppe, pampas and prairie (if these are true climaxes) appears to be absent, a grouping into eight main floristic grass associations has been made; the thirty or forty floristic types of grass cover which can at present be found in different parts of India are merely stages in succession produced by local variations in edaphic or other natural conditions or by the operation in varying degrees of intensity of the major biotic factors of burning, grazing and cutting.

As, apart from the broad surveys on the Australian pattern now being made by B. W. Taylor, Food and Agriculture Organization field officer in Nicaragua, the information regarding the vegetation and grass associations of Latin America is less complete than that for Africa, the Organization has concentrated first on the latter continent. J. M. Rattray has produced a map of the grass cover of the greater part of Africa on similar floristic lines to those which he had adopted earlier for his map of Southern Rhodesia.

The distribution of the main species contributing to the grass cover of Africa is a matter of considerable economic importance when it is realized that probably more than half the land surface of the continent carries a type of vegetation of which grass is an essential feature. While there already exist a number of vegetation maps of the individual territories of Africa (but only one of the continent as a whole), most if not all of these place the emphasis on the distribution of broad vegetation units which have been classified on a physiognomic or ecological basis. When a floristic classification has been used, the distribution of the woody dominants of the vegetation has generally been mapped, and the identity of the less-prominent but equally significant grass constituents has been touched on only very lightly or omitted altogether.

It is well known that the vegetation of Africa ranges from tropical forest to desert and that it includes a large number of transitional associations; it is often difficult to decide where one type starts and another ends. Rainfall and temperature are the most important factors affecting plant distribution since they are jointly responsible for the amount of moisture which the vegetation receives. When the change in climatic pattern is gradual, the change in physiognomic type is correspondingly slow, and *vice versa*. These changes in appearance are usually associated with changes in the density and nature of the tree population, the merging of forest into woodland, woodland into savannah and savannah into steppe being characteristic of the manner in which woody vegetation reacts to a gradual reduction in the amount of available soil moisture. Fire also plays a very important part in controlling the density of the tree population in Africa. Much of the more open savannah country has developed as a result of frequent burning, and when fire is excluded a tree cover tends to regenerate.

The climatic range of the grass constituents of the types of woody vegetation does not necessarily coincide with that of the associated tree species; while there may be some change in the physiognomy of the vegetation, the botanical nature of the associated grasses may remain unchanged. It has not always been possible to rely entirely on vegetation maps based on physiognomy as an accurate guide to the main grass species unless the changes in climatic pattern are sufficiently drastic to cause very considerable changes in the type of vegetation. One of the chief difficulties in compiling the Food and Agriculture Organization map has been the linking up of adjacent territories from the existing information and maps. Frequently the botanical composition of the grass cover would appear to undergo a complete change precisely on the boundary between two countries. Sometimes this may be attributed to the fact that there mountain ranges form the dividing line, for example, between certain East African territories, so that the climatic pattern on either side is sufficiently different to affect the composition of the vegetation. In other areas, however, the sudden change would appear to have resulted from differences in the technique of surveying or nomenclature, or in the interpretation of the vegetation types by those responsible for botanical surveys. In addition, the time of year when the survey was conducted is very important in relation to the dominance of the grass species in particular; surveys made early in the growing season frequently give a very different picture from those made late in the season, especially in the absence of plant counts. Where this situation arose, lists were obtained of the species which occur on both sides of the boundary; those which are characteristic of the area as a whole were ascertained, and a degree of continuity between the botanical composition of the grass cover in the neighbouring territories was thus obtained.

In the Food and Agriculture Organization map of Africa, emphasis has been placed first on the distribution of the main grass associations characterized, but not necessarily dominated, by a particular genus, and secondly, on the type of vegetation with which these are commonly found. The sixteen main types

of grass associations, with a number of sub-associations which have been recognized within each main class, are as follow:

Main grass associations in Africa	No. of sub-associations	Main grass associations in Africa	No. of sub-associations
Andropogon	7	*Exotheca*	1
Aristida	8	*Heteropogon*	1
Cenchrus	2	*Hyparrhenia*	30
Chasmopodium	2	*Loudetia*	4
Chloris	1	*Panicum*	3
Chrysopogon	6	*Pennisetum*	3
Ehrharta	1	*Setaria*	2
Eragrostis	7	*Themeda*	22

The main grass associations are given in different colours (sixteen in all); these colours are entered in the map in various shadings and hatchings to indicate the occurrence of the grass type in different physiognomic formations. Thus the colour blue indicates management of lesser-known grasslands in, for of this basic blue colour represent: (1) species of *Hyparrhenia* and other grasses, forming grassland; (2) species of *Hyparrhenia* and other grasses, associated with woodland of varying density; (3) species of *Hyparrhenia* and other grasses, associated with savannah of varying density; (4) species of *Hyparrhenia* and other grasses, associated with tree steppe.

Within these types are entered a letter and number to indicate the approximate location of a particular sub-type; the thirty sub-types within the main *Hyparrhenia* type are therefore entered as *H*1 to *H*30. The accompanying text indicates in varying degrees of completeness, depending on the information available, the associated grass, tree and other species, altitude, rainfall and present management as grazing land or utilization as crop land.

These basic studies on the distribution of types of grass associations in Africa, when considered alongside the results being obtained in India and northern Australia, may be used for a number of purposes. Within the overall picture of distribution of tropical grasslands, it is expected that these studies will show a considerable degree of similarity between the types of grass cover in the great arc of lands from central, east and north-east Africa to India, and on to northern Australia. As knowledge of this type accumulates, it should be applicable to the ecological management of lesser-known grasslands in, for example, West and East Pakistan, Ceylon, Burma and the countries of south-east Asia. Since the greater part of the grass cover in the deforested areas of tropical and sub-tropical Latin America is dominated by species which may have been fortuitously or intentionally introduced from Africa, the experience obtained and the technique of mapping adopted in the preparation of the Food and Agriculture Organization map of Africa should be of great value when the Organization comes to prepare a map of the grass cover of Latin America.

From the point of view of management of natural vegetation for grazing purposes, it should be possible to transpose methods which have been worked out for one region of Africa to another with a similar type of grass cover but lacking adequate facilities for research. In the text accompanying the map it has been possible to give full details regarding management for the grass types which occur in Southern Rhodesia and Kenya, covering such aspects as the duration of the grazing season, the need for resting vegetation from time to time and the place of burning in a system of management. The ultimate objective is to be able to give this type of information for all the economically important types of grass cover in Africa. It should further be possible to use the grass map in association with soil and climatic maps to indicate the capability of various land classes for the cultivation of specific crops in fertility-maintaining rotations, bearing in mind always the optimal conservation of vegetation, soil and water.

BIOLOGICAL PRODUCTIVITY OF BRITAIN

A SYMPOSIUM on "The Biological Productivity of Britain", organized by the Institute of Biology, was held during October 4–5, in the lecture theatre of the Royal Geographical Society. It attempted to survey present and possible future production from agriculture, horticulture and forestry, from the uncultivated uplands and from rivers and inland waters of Britain. So large a subject could not be covered in detail, and some important aspects of it, notably the losses from diseases and pests, were deliberately omitted; it is hoped that these may provide subjects for future symposia.

The proceedings were opened by Lord St. Aldwyn, Parliamentary Secretary to the Ministry of Agriculture, Fisheries and Food, who said that the Institute of Biology, by providing a forum for interchange of ideas between scientists of many different disciplines, and acting as a focus of views of biologists, is of great value to the Government, which regards it as its function to encourage, assist and put on a sound organizational basis the work of the scientist in the biological field. The promotion of an efficient agriculture is a vital interest of the community, and so the elucidation by biologists of productive potential takes place in a favourable climate of opinion. How far this potential can be realized depends on economic, social, psychological and political considerations, but that does not diminish the value of asking the fundamental questions.

The first session, with Prof. H. D. Kay as chairman, dealt with limitations on production set by the available land area and by climatic and physiological factors. Prof. L. Dudley Stamp (London School of Economics) said that the pattern of land-use in Britain is remarkably stable; it is determined mainly by elevation, slope and rainfall, with soil-type as a more local influence. He advocated that classification of land to indicate its agricultural potential should in future be based on the number of standard nutrition units (each equal to 10^6 calories per annum, sufficient to support one human being in health) that can be produced per acre. Recent changes in land use, described by Dr. G. P. Wibberley (Wye College), are difficult to assess quantitatively because of the inaccuracy of the records; thus loss of farm-land to other uses, mainly urban development, in England and Wales during 1900–50 was nearly twice as great as indicated by the official statistics, and

amounted to 2¼ million acres. Discussion of these papers revealed disagreements about the economics of glasshouse production, emphasized that urban land is not wholly sterile—it was said to account for about 5 per cent of home food production at present, and for about 10 per cent during the Second World War—and questioned the validity of a standard nutrition unit based only on calories and ignoring quality aspects of food, especially protein content.

Biological productivity depends ultimately on factors that limit total photosynthesis per unit area of land. Dr. D. J. Watson (Rothamsted Experimental Station) showed that there is little hope of improving the photosynthetic efficiency of field crops, and as the maximal leaf area of some species is already close to the optimum for dry-matter production, the main possibility for increasing yield lies in increasing leaf area during parts of the growth period when it is small. Possible ways of doing this, such as breeding for frost resistance to permit earlier leaf growth in spring, and the use of gibberellic acid, were suggested by several speakers, and others speculated on the ideal architecture of a crop plant.

The second session, with Mr. F. C. Bawden in the chair, began with an account by Dr. H. G. Sanders (Ministry of Agriculture, Fisheries and Food) of present agricultural production in Britain, which he thought "just about right", though undeniably below the biological potential of the land. The fertility of the soil is well maintained, but drainage has been neglected. Production of good-quality beef and lamb should be increased, and this depends on improvements in production, conservation and utilization of grassland herbage.

The development of more efficient systems of husbandry calls for improved varieties of crop plants adapted to changed environmental conditions. Dr. G. D. H. Bell (Plant Breeding Institute, Cambridge) described the methods of controlled hybridization and selection used by plant breeders for producing new varieties to satisfy particular needs. Of the newer techniques, chromosome doubling has already produced commercially valuable polyploid strains of sugar beet. The chief value of mutations induced artificially by ionizing radiation or chemical treatment may be to provide new parental types for hybridization.

In a paper on expansion of animal production, Prof. M. McG. Cooper (King's College, Newcastle) agreed with Dr. Sanders that only beef and lamb production should be increased; there is already some over-production of eggs and milk. The high intensity of grassland farming appropriate for milk production may not be so effective for fat lamb or beef. Much beef production would have to be a by-product of dairying, using steers bred from dairy cows by beef bulls, and reared by more economical methods based on early weaning and the use of antibiotics. Singularly little progress has been made in the past fifty years in improving the inherent quality of farm livestock, partly because most herds and flocks are too small to be effective breeding units. British livestock are performing well below their potential, and the basic problem still is adequate agricultural education.

Some very variable estimates of productivity per man in British agriculture were put forward in the subsequent discussion, ranging from nearly £700 a year to zero or a negative amount depending on how far subsidies are allowed to enter into the sum. It was claimed that capital invested in reclamation of waste land in the lowlands would give a greater return than schemes for improving hill land. It was also suggested that soils of low productivity should be improved by using earth-moving machinery to mix adjacent heavy clays and light sands, and that more wild species of animals and plants might be domesticated.

Mr. E. M. Nicholson took the chair for the third session, which dealt with productivity of rivers, lakes and forests. Dr. J. W. G. Lund (Freshwater Biological Association, Windermere) stressed the lack of information on primary production in fresh waters; most studies considered only the phytoplankton, but in fresh water benthic plants may produce far more than the plankton. The standing crop may give a fallacious idea of the primary production, if it is not measured at short intervals. There is at present little economic interest in increasing the production of aquatic plants; on the contrary, water undertakings and some industries are concerned to keep it at a low level. In a paper on the production of fish, Mr. E. D. Le Cren (Freshwater Biological Association, Windermere) said that under intensive management fresh waters can produce large crops of first-class protein that compare favourably with agriculture in yield and economic value, but except for trout there is no market for freshwater fish in Britain. A large part of the productivity of British waters goes towards the production of eggs and milt and the rearing of fry that then die; the angler catches only a tiny fraction of the fish-flesh produced, and then returns much of it in fear of depleting the spawning stock.

Present production from forestry in Britain, unlike that from agriculture, is far from being "just about right". Mr. M. V. Laurie (Forestry Research Station, Farnham) said that per head of population it is nearly the lowest in Europe, and satisfies only 10 per cent of Britain's timber requirements. Since the War, the programme of reafforestation is falling behind for lack of sites within the narrow range between what is unsuitable for agriculture and what is unsuitable for forestry, and research is in progress to extend the planting limits that are set mainly by exposure, which prevents planting above 1,500 ft., and by depth of soil. Dr. J. D. Ovington (Merlewood Research Station, Nature Conservancy) said that forestry has ceased to be exploitation of natural vegetation, and sylviculturists are attempting to domesticate trees, just as herbaceous plants were domesticated for agriculture. How far better management techniques, introduction of new species, and breeding for desirable qualities can raise the productivity of British woodlands is doubtful, because little is known about the ecological factors that control productivity. Fertilizers may be necessary for sustained production over long periods. Growth studies on an age series of Scots pine plantations showed greater annual dry-matter production than by neighbouring agricultural crops, presumably because of the continuous leaf cover, but only a small fraction of the dry matter produced in woodland is utilized by man; controlled grazing of the ground flora might be one way of increasing it.

The discussion covered a wide range of topics including the value of leguminous ground crops in young forest, the effect of coniferous trees on soil *p*H, the influence of different tree species on soil formation, the effect of forest cover on the supply of water from a catchment area, and the possibility of using some good agricultural land for hardwood forest.

In the fourth session there were papers on water control for increased crop production, the future of British uplands and unconventional production of foodstuffs. Dr. H. L. Penman (Rothamsted Experimental Station) said that though the agricultural value of field drainage is undoubted, there are no data that give a quantitative measure of it. More than half the clay lands in England and Wales are inadequately drained. In the eastern counties, irrigation would increase production of potatoes, sugar beet and grass in a majority of seasons, but to have a significant effect on national food production a very large amount of water would have to be provided by impounding winter rain that at present runs to waste, or by importation from elsewhere in Britain.

Prof. J. B. Cragg (University of Durham) advocated a multi-purpose use of the uplands, based on ecological surveys and a classification of the capability of the land. Extractive processes such as grazing should be so arranged that the ecological complex of soil, flora and fauna retains sufficient reserves and variety to resist deterioration. In some areas fertilizer application may suffice to fit the soil for grassland or crop production; in others of lower mineral status reafforestation may be essential to restore fertility, or removal of peat deposits may expose soils capable of agricultural development.

The most extreme unconventionality in food production would be total synthesis, but Mr. N. W. Pirie (Rothamsted Experimental Station) thought this could provide only a small fraction of future food supplies, because of the scale of the industry required. The primary source of food would probably continue to be higher plants grown essentially as they grow now; but biochemical engineering, by developing ways of separating edible fractions from plant material that is not directly suitable for human consumption, may enable more productive plant species to be cultivated, and circumvent wasteful conversion by animals. As a practical example, Mr. Pirie provided samples of food containing leaf protein for the audience to taste.

In summing-up the symposium, the chairman, Prof. W. H. Pearsall, directed attention to two omissions: there had been no detailed reference to the importance of either carbon dioxide or nitrogen supplies in biological production. A biological criterion of land use was required, and he suggested that the availability of soil nitrogen should determine whether a site is used mainly for protein production or for cellulose production. The meeting finished with a general discussion which referred to water meadows, human tolerance of plant protein, the yield of mass cultures of green algæ, the carbon dioxide content of the internal atmosphere of leaves, and the advantages of mixed farming. Several speakers stressed the need for better administrative machinery to decide between competing uses of marginal land.

Two distinct problems were considered in this symposium: first, the potential biological productivity from the land of Britain, and secondly, what is desirable or practicable in the current state of economics and politics. It was made clear that present production is far short of the potential, and this is a comforting thing, because with world population rapidly increasing Britain may need to produce more food in the future. It is therefore vitally important to get information now on all possible ways of increasing yield, so that the maximum can be produced when the economic situation demands it.

A full account of the proceedings of the symposium will shortly be published by the Institute of Biology.

D. J. Watson

SMOKING HABITS AND MORTALITY AMONG WORKERS IN CIGARETTE FACTORIES

A PAPER entitled "Smoking Habits and Mortality among Workers in Cigarette Factories", by H. B. Haag and H. R. Hanmer, was read before the Section on Industrial Medicine and Surgery of the Southern Medical Association at its 51st annual meeting at Miami Beach, Florida, on November 14. The paper deals with a four-year survey of the mortality among permanent employees and retired employees in nine processing plants of the American Tobacco Company and links this with observations made by Finkner and his co-workers[1] on the smoking habits of cigarette factory employees and by Haenszel and others[2] on the smoking habits of the 'general population' of the United States.

Haag and Hanmer conclude that their study of this sub-population shows "a higher-than-average percentage of smokers and a much higher-than-average rate of smoking to be associated with greater longevity, relatively lower death rates from cancer and cardiovascular diseases and respiratory cancer rates no higher than the general population". Their results are summarized in Table 1.

The authors make two further claims:

(1) That "The existence of such a population makes it evident that cigarette smoking *per se* is not necessarily or invariably associated with a higher risk of lung cancer or cardiovascular diseases or with diminished longevity". (2) "This finding assumes added significance from the fact that no sampling error is involved in the methodology." This refers to the statement of the results, not to the first claim.

The first commendably restrained and qualified claim can in fact only be made if the second claim is true.

Table 1. Observed and Expected Number of Deaths from Specified Causes among Full-time and Retired Employees of Cigarette Plants and Stemmeries of the American Tobacco Company during January 1953–December 1956

Cause	Expected No. of deaths	Observed No. of deaths	Ratio: expected to observed
All causes	350	241	1·45
Cancer—all forms (140–205)	61	47	1·30
Cancer—respiratory system (160–164)	10	10	1·00
Cancer of trachea, bronchus and lung, specified as primary (162)	4	4	1·00
Cardiovascular diseases (400–468)	137	104	1·32
Coronary disease (420)	82	56	1·46

Numbers in parenthesis refer to cause-of-death codes of the sixth revision of the international statistical classification, 1948, as used in "Vital Statistics of the United States"

It is one of the penalties of writing about such inflammatory topics as the alleged etiological role of smoking in the development of lung cancer that it is almost certain that irresponsible as well as responsible use will be made of any conclusions, with respect both to the influencing of personal habits and to the pursuit of wealth. Because of this possibility, the logical credentials of any investigation that appears to throw new light on the matter should be subjected to careful scrutiny.

In the paper under consideration the methods employed involve a comparison between the 'expected' number of deaths from different causes that would have occurred if the death-rates for the general population were in fact operating on the sub-section of the population under consideration, and the observed number of deaths that did in fact occur in the sub-section.

The arguments employed are based upon the partly explicit premise that the employees of the American Tobacco Company include a higher proportion of regular smokers, and that these smokers have a higher personal cigarette consumption, than the general population; and that this difference is sufficient to warrant the inference that, if it were true that smoking has the etiological effect claimed with respect to the diseases under consideration, the mortality from these diseases would, under the conditions of the study, necessarily be higher than the 'expected' mortality.

An implicit premise of the arguments is that the sub-section of the population differs from the general population, in respect of all those attributes that may render them liable to succumb to the diseases considered, only in their smoking habits, which form the subject of the investigation, and in age, sex, and colour distribution for which allowance can be made by using the appropriate specific death-rates.

Let us now examine the first premise. The reported association[3] between smoking and lung cancer is more marked than that between smoking and the other causes of death under consideration. It is therefore appropriate to use this alleged association to see what effect the recorded alteration of smoking habits[1,2] would have on the 'expected' number of deaths derived from the death-rates of the general population if the finding of Hammond and Horn accurately reflects the degree of association.

From these data and those provided by the authors it has been possible, by making certain assumptions, to calculate the factor by which the 'expected' number of deaths would have to be multiplied, because of the change in smoking habits, if Hammond and Horn's hypothesis is correct. The required factor is 1·7, so that the 'expected' number of lung cancer deaths would become 7 instead of 4 as a result of the change.

The assumptions which, in the absence of more precise information, have been made are that the lung cancer 'expectation' is derived largely from male employees (and retired employees) aged between fifty and seventy, and that the age distribution of these employees is the same as that in the general male population of the United States. If much of the 'expectation' is derived from male employees under fifty or from female employees, or if the number of male employees tail off with advancing age more rapidly than the number in the general population, the factor of 1·7 will have to be reduced, perhaps substantially.

Although the data for allowing for colour difference are not available, there is no reason to believe that this would affect the factor profoundly.

The sample size of the survey was such that 4 deaths from lung cancer were expected at the rates for the general population. Applying the conventional test of significance at the $P = 0{\cdot}05$ level, that is, $\pm 2 \times \sqrt{(\text{expectation})}$, the investigation could not have discriminated, at this significance level, between an observed value of 0 and 8. Since the hypothesis of Hammond and Horn only requires an observed value of 7, the conditions of the study are not such that it could have detected the difference of lung cancer mortality that would have resulted from the changed smoking pattern of the American Tobacco Company employees if Hammond and Horn's hypothesis were true.

This reasoning does not apply to cases of the diseases other than respiratory cancer under consideration, where a marked deficiency of the observed deaths compared to 'expected' deaths is found. These diseases, except for the unspecified ones in the group 'all causes', are relatively chronic ones. This circumstance should at once lead us to examine the second premise, and to ask whether the sub-section of the population, the American Tobacco Company employees, is in fact representative of the general population of the United States in respect of all the attributes, other than smoking habits, age, sex, and colour, that may render its members more liable to succumb to the diseases under consideration.

The study does not mention how the American Tobacco Company selects its employees, how rapid the labour turnover is, what the sex, age and colour distribution is, or how long the employees have been with the Company. Furthermore, the authors do not state that any cognizance has been taken of past employees who leave for reasons other than retirement.

If any kind of medical screening is employed, the sub-population at once ceases to be representative of the general population, and the difference may easily be such as to invalidate any conclusions that may be drawn from the application of rates derived from the general population.

In a survey covering a relatively short period of time (four years) and which is dealing with chronic diseases, this source of bias can be particularly important. The bias will become even more marked if the labour turnover is high, since there will always be a large proportion of the sub-population who have recently been admitted to it because they were found to be free from disease. Further bias might be introduced if there were a selective wastage due to employees with early signs of chronic disease seeking more suitable employment.

It must therefore be concluded that the evidence at present advanced in this paper does not warrant the claim that "no sampling error is involved in the methodology", and until further evidence can be produced to satisfy readers that the methodology is in fact valid, judgment on the first claim, that "The existence of such a population makes it evident that cigarette smoking *per se* is not necessarily or invariably associated with a higher risk of lung cancer or cardiovascular diseases or with diminished longevity", should be reserved. With regard to the specific topic of lung cancer and smoking, it would be necessary in addition to enlarge the survey considerably before the conclusions of Hammond and Horn could be refuted.

Since the topic is of considerable importance to the public health it is to be hoped that the authors will be able to provide the missing background information and to extend the survey. If it is at all possible, it would be highly desirable to extend the survey to discriminate between the different smoking categories within the American Tobacco Company employees, and to see if a mortality gradient corresponding to cigarette consumption is shown. Unless and until the survey is extended and doubts about methodology dispelled, the authors' conclusions should not be used as a guide to human behaviour.

R. A. M. Case

[1] Finkner, A. L., Horvitz, D. G., Foradori, G. T., Fleischer, J., and Monroe, J., University of North Carolina Institute of Statistics. Mimeo Series No. 177 (1957).
[2] Haenszel, W., Shimkin, M. B., and Miller, H. P., Public Health Monograph No. 45 (U.S. Department of Health, Education and Welfare, 1956).
[3] Hammond, E. C., and Horn, D., *J. Amer. Med. Assoc.*, **155**, 1316 1954).

NEWS and VIEWS

New Year Honours List

The following names of scientists and others associated with scientific work appear in the New Year Honours list:

Baronet: Sir Harry Platt, lately president of the Royal College of Surgeons.

G.C.V.O.: Sir Stewart Duke-Elder.

C.H.: Viscount Nuffield.

K.C.B.: Dr. Harry W. Melville, secretary, Department of Scientific and Industrial Research.

K.B.E.: Maurice E. Adams, civil engineer-in-chief, Admiralty.

Knights: William R. J. Cook, deputy director, Atomic Weapons Research Establishment, Aldermaston (United Kingdom Atomic Energy Authority); Dr. Julian S. Huxley; Prof. Christopher K. Ingold, professor of chemistry, University of London (University College); Prof. Hans A. Krebs, Whitley professor of biochemistry, University of Oxford, and honorary director of the Cell Metabolism Research Unit of the Medical Research Council; Dr. Ernest Marsden, member of the New Zealand Council for Scientific and Industrial Research; John W. Worboys, chairman, Council of Industrial Design, a director of Imperial Chemical Industries, Ltd.

C.B.: Hayne Constant, director, National Gas Turbine Establishment (Ministry of Supply); J. E. Serby, director-general, Guided Weapons (Ministry of Supply); H. Tetley, deputy government actuary.

C.M.G.: A. L. P. Kirwan, director and secretary, Royal Geographical Society.

C.B.E.: P. H. Andrews, assistant secretary, Ministry of Agriculture, Fisheries and Food; Dr. C. R. Burch, Warren Research Fellow in physics, University of Bristol; A. E. Crook, principal inspector of mechanical engineering, Mines Inspectorate (Ministry of Power); Prof. H. J. Emeléus, professor of inorganic chemistry, University of Cambridge; Prof. R. H. Evans, professor of civil engineering, University of Leeds; W. N. Foster, petroleum technologist, Trinidad; D. L. Gunn, director, International Red Locust Control Service, Northern Rhodesia; H. W. Harvey, senior principal scientific officer, Laboratory of the Marine Biological Association of the United Kingdom, Plymouth; L. Hughes, deputy chief veterinary officer, Ministry of Agriculture, Fisheries and Food; Dr. C. H. Johnson, director, Materials and Explosives Research and Development, Ministry of Supply; W. E. Lancaster, lately director of veterinary services, Federation of Malaya; H. B. McCance, chairman of council, Linen Industry Research Association; Prof. P. B. Medawar, Jodrell professor of zoology and comparative anatomy, University College, London; Dr. G. A. Reay, superintendent, Torry Research Station, Food Investigation Organization, Department of Scientific and Industrial Research; Prof. I. A. Richmond, professor of archæology of the Roman Empire, University of Oxford; H. Service, lately director, Geological Survey, Malaya; G. D. Sharman, assistant secretary, Department of Agriculture for Scotland; Dr. R. W. West, principal, Battersea College of Technology; J. Wilson, director of research, British Rayon Research Association.

Mechanical Engineering in the University of Western Australia: Prof. D. J. F. Allen-Williams

Dr. D. J. F. Allen-Williams, who has recently been appointed to the chair of mechanical engineering in the University of Western Australia, is thirty-nine. He was educated at Harrow School and Clare College, Cambridge, where he took Part I of the Mathematical Tripos and then in 1939 the Mechanical Sciences Tripos. After some official civil engineering work in 1939, he was seconded in 1940 to the Air Ministry Research Establishment, Swanage (later known as the Telecommunications Research Establishment). He worked mainly on radar countermeasures and after a visit to the United States was posted in 1945 to the headquarters of South East Asia Command. He was recalled in October 1945 to become group leader in electronic instrumentation for nuclear physics at the Telecommunications Research Establishment, Malvern. In October 1946 he returned to Cambridge as a research student in the Department of Radiotherapeutics. His main work was the development of the 30-MeV. synchrotron as a radiotherapeutic instrument. By his efforts, Dr. Allen-Williams made it practicable to carry out a useful, though limited, clinical trial with a machine which was found to present a great many difficulties. In 1950 he was elected to a British Empire Cancer Campaign Junior Fellowship to continue his work on the synchrotron and its applications to radiotherapy. In 1952 he received the degree of Ph.D. (Cantab.) for a thesis on this work, and in October 1953 was appointed physicist with special reference to the applications of electronics to radiotherapeutics in the Department of Radiotherapeutics of the University of Cambridge. In November 1954 he joined the Ruxton–Paxman Group of companies to study the development of nuclear energy in industry, and in July 1955 he was appointed senior research engineer with Davey, Paxman and Co., Ltd. He has always been interested in the contributions of engineering to social betterment and the improvement of conditions of living.

Civil Engineering at Southampton : Prof. P. B. Morice

In view of the recent and forthcoming growth in the size of the Engineering Faculty, the University of Southampton has decided to increase the number of chairs in the faculty. In accordance with this policy, the University has instituted a chair of civil engineering; the first professor will be Dr. P. B. Morice. After taking his degree at the University of Bristol, Dr. Morice was for a time with the Surrey County Council Highways and Bridges Department. Since 1948 he has been with the Research Division of the Cement and Concrete Association, and has been for a number of years head of the Structures Research Department. His main interests lie in the fields of pre-stressed concrete and in the theory of structural analysis. The University of Southampton can look forward to the vigorous growth of the Civil Engineering Department now that it has at its head a professor with an outstanding record of research.

Geology at Exeter : Prof. Alan Stuart

The establishment of a chair of geology in the University of Exeter is a further stage in the growth of that young institution. Mr. Alan Stuart had the task of laying the foundations of a Department of Geology twelve years ago, and a measure of the success of his efforts is now his promotion to a professorship. Prof. Stuart received his undergraduate training, after service in the First World War, in the University of Durham, specializing in mineralogy and petrology under the guidance of Dr. L. Hawkes. In 1921 he was appointed to the staff of the new University College of Swansea, where for twenty-five years he was not only responsible for much of the geological teaching and the building of the Department, but also undertook part of the College administration, notably as superintendent of examinations. He thus had experience in university affairs that stood him in good stead when he assumed his duties in Exeter in 1947. Prof. Stuart's interests have been wide: he has published work on the petrology of coal, on magnetite sands, on the mineralogy of the Old Red Sandstone and of recent dune sands, and on the ontogeny of gastropod shells. More recently he has devoted special attention to optical methods in mineralogical and crystallographic analysis, and is joint author with N. H. Hartshorne of the standard work "Crystals and the Polarizing Microscope". It is a fitting conclusion to a devoted university career that Exeter should have thought it proper to appoint him to the chair.

The Royal Society : Vice-presidents for 1958

Sir Cyril Hinshelwood, president of the Royal Society, has appointed the following vice-presidents for the year ending November 30, 1958: Sir William Penney, treasurer of the Royal Society, director of the Atomic Weapons Research Establishment, Aldermaston; Sir Lindor Brown, biological secretary of the Royal Society, Jodrell professor of physiology at University College, London; Sir Charles Dodds, Courtauld professor of biochemistry in the University of London; Sir Bryan Matthews, professor of physiology in the University of Cambridge.

European Organization for Nuclear Research : Appointments

M. François de Rose, a member of the French Atomic Energy Commission, has been elected president of the European Organization for Nuclear Research (C.E.R.N.) in succession to Sir Ben Lockspeiser, who guided the Organization during its formative period and is retiring on completion of the statutory three-year term of office. Mr. J. Willems, of Belgium, and Prof. W. Heisenberg, of Germany, have been elected vice-presidents. They succeed Mr. F. de Rose, of France, and Prof. Holtsmark, of Norway. Prof. E. Amaldi, of Italy, has assumed the chairmanship of the Scientific Policy Committee, succeeding Prof. W. Heisenberg of Germany. Mr. J. H. Bannier, of the Netherlands, has been appointed chairman of the Finance Committee, in succession to Mr. J. Willems, of Belgium. Sir Harry Melville, secretary of the Department of Scientific and Industrial Research, has been appointed to succeed Sir Ben Lockspeiser as one of the British delegates to the Council of the Organization, the other delegate being Sir John Cockcroft. During 1957 the entire staff of the Organization moved into its permanent headquarters at Meyrin, near Geneva. The total number of personnel is now 598, of which about two-thirds are scientific and technical.

American Hall of Fame

Bronze busts of George Westinghouse, inventor of the air brake, and Josiah Willard Gibbs, the thermodynamicist, are to be placed in the Hall of Fame for Great Americans at the University of New York. At an unveiling ceremony, held on December 1 in the Gould Memorial Library Auditorium of the University of New York, the bronzes were accepted by Dr. C. V. Newsom, president of the University. The principal speakers were Mr. Herbert C. Hoover, former president of the United States, and Dr. D. W. Bronk, president of the U.S. National Academy of Sciences. The bust of Westinghouse, which was given by the American Society of Mechanical Engineers, was sculptured by Edmondo Quattrocchi. The bust of Gibbs, a gift of the American Chemical Society, Yale University, and several individual donors, is by Stanley Martineau.

Site for Expansion of the University of St. Andrews

A statement by the Secretary of State for Scotland, circulated with Hansard for December 17, regarding his decision on the building site for the University of St. Andrews, which was challenged both on procedure and on merits, points out that while the University's evidence at the inquiry was given after the evidence for the objectors, the lines of the University's case had been made clear in advance and its witnesses were intensively cross-examined. The Government's broad acceptance of the Franks report did not mean reopening proceedings already concluded. On merits, Mr. J. Maclay said that the inquiry lasted for ten days, during which all aspects of the matter were fully debated, with a further day devoted to the inspection of sites. It was conducted by a senior and very experienced member of the Scottish Bar as commissioner, wholly independent of the Scottish Office, with the assistance of eminent and independent planning assessors, and his decision was in line with the recommendations in the Commissioner's report. A crucial part is the adequacy of the site for the future scientific needs of the University. The University's view that the Westburn Lane site is adequate and suitable for foreseeable needs of basic scientific teaching and research, that peripheral sites are available if any specialized research necessitated

the creation of special buildings at St. Andrews, and that further expansion could still be undertaken at Queen's College, Dundee, was upheld by the Commissioner. Although criticized by the Professor of Physics as shortsighted, this view was supported by the University Grants Committee.

The Commonwealth Trans-Antarctic Expedition

The tractor train of the New Zealand Antarctic expedition led by Sir Edmund Hillary reached the South Pole on the night of January 3. This is the first time that the Pole has been reached overland since the pioneer expeditions of Amundsen and Scott. The expedition, which also includes P. Mulgrew, M. Ellis, J. Bates and D. Wright, reached the American base at the Pole having driven three tractors, two sledges and a caboose 1,200 miles from Scott Base since October 14. The New Zealand expedition, in conjunction with a R.N.Z.A.F. party under Squadron-Leader J. Claydon flying a *Beaver* aircraft, has laid down five depots of food and fuel between Scott Base and Depot 700, about seven degrees of latitude short of the Pole, in support of the United Kingdom trans-Antarctic survey party under Dr. Vivian Fuchs, which proposes to cross the continent from the Weddell Sea to the Ross Sea. At the time of writing, Dr. Fuchs' team, about three hundred miles from the Pole, is encountering hard going from *sastrugi* (ice-ridges) impeding the progress of his tracked vehicles. On January 6 Squadron-Leader J. Lewis, flying an R.A.F. *Otter* single-engine aircraft, traversed the Antarctic continent from the advance British base at South Ice to Scott Base, where Dr. Trevor Hatherington's team of scientists is continuing its programme of observations for the International Geophysical Year.

Soviet and Western Attitudes to Science

The text of a talk entitled "What is the Right Attitude to Science ?" by Dr. K. Mendelssohn, reader in physics in the University of Oxford, broadcast on December 23 on the B.B.C. Third Programme, has recently been published in *The Listener* (January 2, p. 12). Dr. Mendelssohn points out that science and technology, to which the West owes its high standard of living, have been taken so much for granted that they are now accorded second place in the educational system. Now, quite apart from military considerations, the prospect of Russian technological superiority may make it an economic necessity to re-assess the Western position. It is a dogma of Soviet economics that prosperity is based on technological progress, and the rewards to scientists and engineers both in salary and status in the Soviet Union are accordingly high. Even more important is the fact that science in the U.S.S.R. is administered at the highest levels by the Soviet Academy of Sciences and not by politicians or generals. The position is almost the exact opposite in the United States, where the direction of scientific effort is largely in the hands of non-scientists, which not only leads to defective decisions, but also relegates the scientist to a subordinate position. In Britain, on the other hand, while science is mostly directed by scientists, the false dichotomy between science and the humanities has created an almost hostile, or at least defensive, public feeling against science. This, together with early specialization in British schools, has tended to discourage entry into scientific professions. The Russian achievements are largely due to money spent on scientific education and research, even at times when the Soviet Union was passing through economic crises. Dr. Mendelssohn suggests that in Britain more money spent on education could still buy time : time essential for a good general training in both arts and science and for an extra year at a university.

Recent Earthquakes

On December 4 a very great earthquake occurred in Outer Mongolia, with epicentre near latitude 45½° N., longitude 99½° E. The initial time of this shock was 03h. 37m. 45s. G.M.T., and it attained magnitude 7·9 on the Gutenberg–Richter scale. This earthquake was registered on the seismograph at the Royal Observatory, Edinburgh, with maximum ground amplitude of almost 250μ. After-shocks from this and neighbouring epicentres were frequent, especially during the first half of December. Six great aftershocks occurred on December 4, four on December 8 and one each on December 5, 7 and 11, besides numerous smaller ones. All these shocks were registered throughout the world. The area affected macroseismically included the districts of Bayankhongor, Ara Khangai and Ubur Khangai. A wide permanent fissure more than six miles long is said to have appeared in Bayan Tsagan at the time of the earthquake.

On December 13 a smaller earthquake occurred in western Persia with epicentre near latitude 34½° N., longitude 48° E. It had magnitude 7¼, and occurred at 01h. 44m. 59s. G.M.T. It was registered on the seismograph at the Royal Observatory, Edinburgh. The macroseismic effects of this shock were very great in the triangle bounded by Kermanshah, Hamadan and Sanandaj. Murdistan, Assadabad and Kangavar were severely damaged, and Farsinaj was almost destroyed. The earthquake may have caused the deaths of 2,000 people.

The Griffin Gas Chromatography Apparatus

Messrs. Griffin and George, Ltd., have issued a very well-produced pamphlet describing the Mark 2 version of their gas chromatography apparatus. This pamphlet is profusely illustrated with diagrams and photographs, and also contains a short bibliography which will be useful to anyone intending to use gas chromatography for the first time. Typical chromatograms obtained with the Griffin and George equipment are reproduced, and these illustrate the versatility of gas chromatography, showing the analysis of a range of compounds from the C_3–C_{18} fatty acids and their esters, to a series of simple aromatic hydrocarbons. Some indication of the special virtues of a number of different stationary phases is given in a short table.

Zoological Nomenclature

The International Trust for Zoological Nomenclature has arranged for the publication in book form of the first instalment of each of the "Official Lists" of valid zoological names and of the corresponding "Official Indexes" of rejected and invalid names, together with the first instalment of the "Official Lists" of work approved as available for zoological nomenclature and of the "Official Index" of rejected and invalid works. The categories of names covered by these lists and indexes range from specific names to ordinal names, and the total number of entries now to be published is about five thousand. The first of these lists, relating to generic names, was

established by the Ninth International Congress of Zoology held at Monaco in 1913, while the most recent were brought into existence by the Fourteenth Congress at Copenhagen in 1953, but owing to the large number of documents now involved it has become difficult for specialists to ascertain what names have so far been registered. This difficulty will be removed by the new publications, each of which will be supplied both with a full alphabetical index and also with alphabetical indexes arranged by major groups. The groups so selected will normally be classes, but in the case of large classes containing well-recognized orders, these supplementary indexes will be on an ordinal basis. All inquiries should be addressed to the International Trust for Zoological Nomenclature at its Publications Office, 41 Queen's Gate, London, S.W.7.

Royal Society and Nuffield Foundation Commonwealth Bursaries

THE following awards under the Royal Society and Nuffield Foundation Commonwealth Bursaries scheme have been announced : Mr. J. Attridge, assistant lecturer in zoology, Birkbeck College, University of London, to enable him to collect and study Karroo vertebrate fossils in Southern Rhodesia during June–October 1958 ; Colonel S. S. Bhatnagar, St. Xavier's College, Bombay, for the study of procedures for the characterization of chemical and pharmacological principles of plants, at Cambridge during April and May 1958 ; Dr. A. J. Buller, senior lecturer in physiology, St. Thomas's Hospital Medical School, London, to enable him to gain practical experience in studying the nervous system by the microelectrode techniques, at Canberra, for about ten months from March 1958 ; Mr. J. Dainty, reader in biophysics, University of Edinburgh, for research on the ionic relations of plant cells and the electrical properties of plant cell membranes, at Sydney, during March–September 1958 ; Dr. W. P. U. Jackson, of the Department of Medicine, University of Cape Town, for the study of specific methods and techniques in endocrine research (prediabetes, plasma insulin activity, calcium and phosphate metabolism) in London, Cambridge and Louvain, during June–August 1958 ; Mr. C. St. J. Lamb, lecturer in electrical engineering, New South Wales University of Technology, to enable him to assist in the development of instrumentation of nuclear reactors used for the production of electrical energy, at Erith, Kent, for a year from January 1958.

University News : Birmingham

THE title of reader in physiology has been conferred on Dr. I. C. Whitfield, senior lecturer in physiology. The following appointments have also recently been made : Dr. R. L. Holmes, to be senior lecturer in anatomy ; Dr. T. R. Lomer, to be lecturer in physics ; Dr. G. Gregory, to be staff tutor in the Institute for Engineering Production ; F. D. Hobbs, to be Paviors lecturer in highway engineering in the Department of Civil Engineering ; and L. Kay, to be lecturer in electrical engineering.

Two new graduate courses have been established in the Faculty of Science : one is a course in the Department of Pure Mathematics leading to a diploma in mathematical statistics, and the other is a course in operational research in the Department of Engineering Production leading to the degree of M.Sc. by examination.

London

THE title of professor of pathology in the University of London has been conferred on Mr. M. H. Ashton in respect of his post at the Institute of Ophthalmology. The title of reader in the University has also been conferred on the following : Dr. A. Armitage (history and philosophy of science) at University College, Dr. Ivy Pinchbeck (social studies) at Bedford College, Dr. C. A. B. Smith (genetical statistics) at University College, and Mr. R. J. Wilkins (civil engineering) at University College.

Malta

IN accordance with the terms of the Royal University of Malta (Constitution) Act of 1957, a Statutory Commission has been formed to "advise the Government on any matter relating to or connected with the University which the Government may refer to them for advice and report, including the expediency of amending or repealing and replacing any Statute for the time being in force or any Regulation made thereunder. No major act of the University which may involve expenditure shall be entered into by the University without the prior approval and advice of the Commissioners who, before giving such approval and advice shall make a report on the matter to the Government and shall consult with the Government on the total amount of funds available. The Commissioners shall also, if so requested by the University, advise the University in the working out of new policies".

Members of the newly appointed Statutory Commission are as follows : Sir Ivor Jennings, Master of Trinity Hall, Cambridge (*chairman*), L. J. F. Brimble, J. S. Fulton and Sir Charles Snow.

Announcements

SIR WILLIAM G. OGG, who has been director of Rothamsted Experimental Station since 1943, will retire on September 30, and the Lawes Agricultural Trust Committee has appointed Mr. F. C. Bawden to succeed him.

PROF. E. LEDERER, of the Institut de Biologie Physico-Chimique, Paris, known for his work on paper chromatography, will be visiting professor in the Department of Chemistry, King's College, University of Durham, Newcastle upon Tyne, for a period of about six weeks, starting on March 4.

THE Institution of the Rubber Industry and the Plastics Institute are holding a joint conference on February 27 at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1. The subject will be "Recent Advances in Polymer Technology". Further information can be obtained from the Secretary, The Plastics Institute, 6 Mandeville Place, London, W.1.

THE Spectroscopic Panel of the Hydrocarbon Research Group of the Institute of Petroleum is organizing a conference on molecular spectroscopy, to be held at the Institution of Electrical Engineers in London during February 27–28. The programme will cover the whole field of spectroscopy. The main topics to be discussed will be nuclear magnetic resonance, technical developments, intermolecular forces and factors affecting intensities of absorption bands. Further information can be obtained from E. Thornton, c/o British Petroleum Co., Ltd., Chertsey Road, Sunbury-on-Thames, Middlesex.

DESIGN OF PHYSICS RESEARCH LABORATORIES

ON November 27, the London and Home Counties Branch of the Institute of Physics held a symposium at the Royal Institution on "The Design of Physics Research Laboratories".

In his introductory remarks, Dr. J. S. Forrest (chairman) recalled that a similar discussion had been held by the Institute of Physics ten years ago (*J. Sci. Instr.*, **25**, 157; 1948). In the intervening decade, however, there has been intense activity in the building of new laboratories. Moreover, the character of the physics research laboratory is changing; the conventional laboratory with standard benches equipped with standard services and apparatus is no longer suitable for dealing with many of to-day's problems, which require large machines with the attendant erection and servicing facilities. Accordingly, the time was ripe for a further discussion to put on record the lessons learned during the past ten years and to present the views of architects and research directors responsible for the planning of modern laboratories.

A basic laboratory design which seems to fulfil modern needs, and which was referred to by several speakers, takes the form of a large central area, perhaps 60 ft. wide, with relatively small enclosed laboratories along the sides. The central area must have adequate head-room (more than 20 ft.) and it is therefore possible to provide a number of smaller enclosed laboratories or offices on a gallery over the ground floor laboratories (Fig. 1).

Prof. Basil Spence said he had been concerned with the design of university physics laboratories. Teaching laboratories had to cope with large numbers of students, but the requirements could be defined clearly. Research laboratories, on the other hand, must be extremely flexible in design, as the nature of the work which might be carried out in a few years time was unknown. He had even had to provide for the possibility of increasing the roof height in one project.

Dr. T. Emerson dealt with some problems in the planning of industrial research laboratories. He emphasized the importance of good team-work between the research director, the architect and the builder. The duties and responsibilities of the various parties should be clearly defined at the outset. The requirements for accommodation and services should be co-ordinated and all instructions passed to the architect by one person only, for example, the building supervisor, who might with advantage be the person responsible for the future maintenance of the finished building. The aim should be to construct an adequate building at reasonable cost with plenty of laboratory space to provide future flexibility, sufficient office accommodation, but no unnecessary frills.

A contribution by Charles S. Haines (read by Mr. D. T. R. Dighton) discussed recent trends in the design of American industrial research facilities. In the United States it is becoming common to put the research facilities on a rural site separate from the manufacturing plant. It is important to provide adequate space for future expansion and car parks, and some companies with research organizations of approximately one hundred persons are acquiring sites of more than 200 acres. The design of the buildings must proceed from the inside outwards. To prevent early obsolescence, modular planning is essential, a module being a "three-dimensional repetitive unit of functional space". The satisfactory width of the laboratory module (usually parallel to the exterior wall) may vary from 9 to 12 ft.; the length may be from 24 to 28 ft. Office modules of 5 ft. × 15 ft. will provide individual and group offices of 10, 15, 20 or 25 ft. × 15 ft. Factory-finished metal partitions are preferred for subdividing laboratories, and they should be designed so that room arrangements may be modified without moving the mechanical and electrical services. Air conditioning is desirable, and fume chambers may be required in physics as well as in chemistry laboratories. Many laboratories built in the period from 1949 to 1954 using cheap materials and poor construction are now beginning to deteriorate. Properly planned sound construction using lasting and easily maintained materials will prove to be more economical.

Mr. B. C. Fleming-Williams spoke on services and facilities from the user's point of view. The permanent services—water, gas and waste pipes, electric

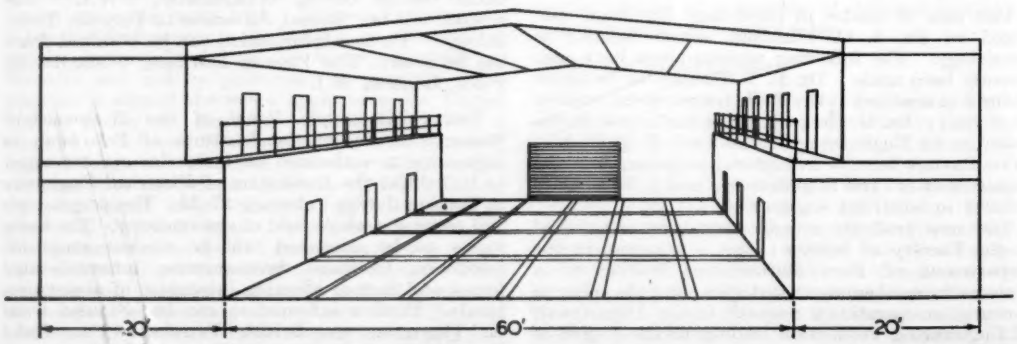

Fig. 1. A basic design for a physics research laboratory

power, lighting, heating and ventilation—should be based on a modular plan. Local supplies may sometimes be preferable to a permanent central installation. For example, direct current can conveniently be supplied from individual power packs instead of from a central battery. Similarly, vacuum requirements can usually be provided by bench pumps, and supplies of various gases from local cylinders. Facilities must be available, however, for the handling and storage of gas cylinders. An adequate and easily accessible duct system should always be installed to enable any central service to be provided at any point if it is found to be desirable in the future.

Mr. J. C. Cornwell discussed buildings and services from the point of view of the laboratory maintenance engineer. He pointed out that maintenance staffs in laboratories are more often concerned with alterations and additions to the buildings and facilities than with simply maintaining the original installation. When the laboratory is designed, provision should be made to facilitate building extensions and alterations to the services. In the choice of partitioning, sound transmission and ease of attachment of shelves are important considerations. Brick and some proprietary types of partitioning are satisfactory, but steel and glass are not. Floor surfaces and their cleaning merit particular attention. Floor ducts should be designed to minimize flooding. Fire protection should receive adequate consideration. Provision must be made for inflammable stores, radioactive sources, gas cylinders and bulky maintenance equipment.

Mr. R. G. Hopkinson spoke on the programme of research on the design of laboratories which is being carried out by the Nuffield Foundation Division for Architectural Studies in collaboration with the Building Research Station. Statistical studies have been made of the bench space and services required by laboratory workers. The work on laboratory lighting was carried out at the Building Research Station. From the determinations of minimum levels of natural and artificial lighting for the efficient performance of laboratory work, a design has been evolved which gives good day-lighting in a single-side lit laboratory. A model was used for assisting in the appraisal of the design (Musgrove, J., and Petherbridge, P., *Architect's J.*, **126**, 368; 1957).

In opening the discussion, Mr. D. A. Oliver suggested that two types of laboratory accommodation are generally required—'open space', costing about £2 per sq. ft., and 'better-class' laboratory accommodation costing about £4 10*s*. per sq. ft. The better-class accommodation should be kept free from noise, vibration and dirt; workshops and heavy machines should be in a separate building.

Other matters discussed were the advantages of air conditioning and electric floor warming in research laboratories; a method of providing a wide range of electricity supplies at the benches; and a colour-light staff location system which also functioned as a fire alarm.

In summing up the symposium, Prof. F. A. Vick said that the physicist must make up his own mind as to his requirements, but it is sometimes important that the outside of laboratory buildings should be in keeping with other adjacent buildings. The use of models could be a great help in planning laboratories. Workshops and equipment causing noise and vibration should be kept separate from the research laboratories and offices. The services should be very carefully designed bearing in mind the many points raised in the discussion, and detailed plans of the services properly colour-coded should be handed over with the building. The laboratory furniture should be designed as part of the building. He agreed that it is false economy to save money on the initial cost of the laboratory—taken over a number of years the capital cost of buildings is not usually a very important item in the research laboratory budget.

J. S. Forrest

COLOUR TELEVISION IN UNIVERSITY TEACHING

Guy's Hospital and Medical School and the British Broadcasting Corporation collaborated to present a series of sixteen demonstrations, lasting more than two hours, which was relayed from Alexandra Palace to Western House, Great Portland Street, London, on the evening of November 19. Marconi's Wireless Telegraph Co., Ltd., provided a colour television projector and a 6 ft. × 4 ft. screen. Although this presentation had been organized for the staff of Guy's Hospital and the Medical School, a large number of representatives from other faculties in the University of London and from medical centres elsewhere were also present.

The purpose was to judge the technical quality of the British system and to consider whether the apparent and potential properties of colour television are sufficiently attractive to warrant a critical trial under practical conditions.

This venture was by no means a stunt. Repeated technical experiments in the research establishment of the Marconi Company at Chelmsford preceded further trials at Alexandra Palace by members of the staff at Guy's representing fourteen different departments. The B.B.C.'s production staff had to evolve new methods and to adapt their equipment to a considerable extent. For example, teaching demonstrations were found to require big close-ups, whereas existing techniques had naturally been designed to satisfy the demands of the theatrical producer. It may be of interest to note that this was the first occasion on which the B.B.C. has transmitted a continuous colour television programme of this length. Meticulous planning was necessary to enable the two cameras to move from one demonstration to the next in less than two minutes. That the presentations followed each other with quite extraordinary precision was the more remarkable as few of the busy physicians and lecturers had been able to attend more than one or two rehearsals. This is a point of importance, as it might be assumed that television techniques in medical teaching will exact undue demands upon the lecturer's time.

The general consensus of opinion was that the quality of definition and colour balance was well above reasonable expectation and most certainly made the use of colour television a practical possibility. It is still to be decided whether this method of communication should be further tested for its effectiveness by a series of critical experiments carried out against the background of university teaching. It was not possible on this occasion to draw any valid conclusions in this respect. The audience consisted of experienced teachers and not students, most of the demonstrations were enacted by senior lecturers, who would normally have been directing such work while

actually with their students; and, of course, a large technical staff was available to handle intricate and bulky equipment. Both equipment and methods will have to be simplified drastically to adapt this medium for use in everyday instruction, and there is every expectation that this could be done. However, only practical experience under realistic conditions will show to what extent and how colour television can contribute to understanding and learning.

It may be of value to consider here the essential properties of colour television and how they might possibly be applied. Events and phenomena can be observed at a distance, even when direct vision is not possible. The moving image can be viewed either on large projection screens, or on smaller television receivers in any desired number of places, by large audiences, at the exact time that events are taking place. Fine detail, such as individual hairs on the back of the hand, and large scenes, such as big machinery in a laboratory, can be portrayed with equal ease. High-power microscopic examinations can be made with considerably higher brilliance than is possible with conventional projection microscopes. Preliminary experiments with endoscopes have proved that their use may well become a commonplace, as soon as the associated optical problems have been solved. Live presentation, films, slides and charts can be shown in immediate sequence, and indeed in any desired admixture.

The images from two or more television cameras can be presented in sequence or even side by side. It will thus be possible to correlate separate aspects of the same subject or to contrast similar phenomena by using more than one camera in quite different locations, as, for example, in a laboratory and in a hospital ward.

Perhaps the most important difference from normal visual records such as diagrams, lantern slides and motion picture films is the fact that a live action is shown on the television screen at the exact moment when it happens. Apart from any other considerations, the psychological effect of this upon a student body may prove to be considerable. Whereas a film is rigid in its construction and presentation and cannot easily be arrested, the television demonstration is entirely under the lecturer's control. He can direct the demonstrator through a two-way radio link, he can ask for an alternative presentation of the same subject or for a repetition when he feels that this would be of greater benefit to the students. Mistakes and defects can be rectified immediately, a process which may in fact add to the value of a demonstration, by emphasizing its immediate and local character, and thus imparting to it a liveliness and personal nature often absent from films. Each demonstration can be varied according to the lecturer's wishes and according to the existing knowledge of his students. Participation by the audience can be used where appropriate, for students can both hear and speak to the demonstrator who is with the camera.

Many will maintain that the motion picture film can be used as effectively and more economically. A brief consideration of this contention will expose its fallacy. Even if funds could be raised to establish and maintain sufficient film production units to make films of all the many subjects which can be shown by television, few teachers would have the time required for drafting the initial treatment and for supervising the scripting, rehearsing, shooting and editing of such films. Even if all these films could be made, they would neither fit in with the ideas of other teachers, nor could they possibly be equally effective for different types of audiences. Some 'date' quickly and there are inevitable delays between preparation and exhibition.

Such handicaps do not apply to television. The lecturer discusses with his assistant what he wishes to demonstrate. The camera is placed in position, and the lecturer can direct and control the proceedings as and when he requires them while talking to his students. This demonstration can be as simple or elaborate as he himself may wish.

The use of good colour, a live presentation, the magnification of small detail for large audiences, the juxtaposition of different events or phenomena separated in space, participation by the audience, and complete control by the lecturer can be regarded as the main characteristics which might be exploited. What effect, in terms of understanding and learning, might this have on students? Which type of student will derive the greatest benefit from colour television and at what stage of his learning? Which teaching situations and which disciplines are most likely to benefit from its use? How should it be used to its best advantage? Finally, is the total effect economically worth while? The answers to these questions can only be established satisfactorily when a centre consisting of many different interests and types of student, both undergraduate and postgraduate, is prepared to undertake a full and unbiased investigation of the method. No one will be optimistic enough to imagine that colour television can solve all problems of teaching, nor will any responsible teacher wish to interpose an elaborate electronic device between himself and his class where the normal direct approach can do all he wishes. Nevertheless, experience already shows that television demonstration may permit valuable additions to the content of teaching in many medical subjects, especially by presentation to large audiences of things it is rarely possible to show even to a handful of students. Doubtless, present views and expectations will be modified, and unsuspected potentialities discovered, when it becomes possible to make a full exploration in the working conditions of a medical centre. The results of such an experiment might prove to have far-reaching effects on education, not only in university circles, but also in schools and perhaps even on television broadcasts to the general public.

A colour sound film recording of the demonstration and a booklet published by Marconi's Wireless Telegraph Co. in collaboration with the Illustration Department of Guy's Hospital Medical School are available.

C. E. Engel
Roger Warwick

AUTOMATION IN THE POST OFFICE

In moving the second reading of the Post Office and Telegraph (Money) Bill in the House of Commons on December 5, the Postmaster-General, Mr. E. Marples, said that during the next two years the Post Office would be spending about £180 million on capital equipment, of which £105 million would be by way of depreciation and ploughed back by the Post Office. Of this sum, more than £167 million would go to telecommunications, £6 million to telegraphs—mostly 'Telex'—and £7 million to postal

services. Amplifying the White Paper (see p. 71 of this issue), Mr. Marples, who doubted whether there had been purposeful direction of science and shrewd timing of applied science in the past, explained how in 1958 the saving of £2 million would be achieved in wages as well as at least £10 million-worth of equipment which would have been scrapped under the old system. To secure the maximum use of the £150 million-worth of buried wires, which is increasing at the rate of £11 million a year, the Post Office is trying to bring the automatic line concentrator into operation as fast as possible, and in 1960 it is hoped to have the first all-electronic exchange in operation at Highgate Woods, as a result of the work of the Joint Electronic Research Group, a partnership between the Post Office and private enterprise. By putting in extra repeaters every three miles, it will be possible to make much better use of the existing coaxial cables, either doubling the number of conversations or providing a television channel.

Dealing with the postal services, Mr. Marples said that the procedure in sorting is essentially the same as that used one hundred years ago; of the total cost of the postal services of £120 million, man-power accounts for 70 per cent. Of that total, sorting accounts for £40 million and delivery for £30 million. The first electronic sorting machine is already in operation at Southampton, and another, the first of a further twenty, should soon be available at Norwich. This development, which is well in advance of the rest of the world, is due to the scientists at Dollis Hill Research Station. It requires for its application a standard envelope, and Mr. Marples emphasized the importance not only of co-operation, particularly with the United States and Canada, in research, but also of public opinion. He said he is starting a scientific survey to find out what the public expect and want from the postal services and how far they are prepared to co-operate, for example, by using a code number for the address. Mentioning the International Committee of Postal Studies, Mr. Marples said that as a result of a visit by the Deputy Postmaster-General of the United States last summer, a team of five Post Office officials has studied mechanization in Canada and in the United States. He had also appointed a committee, with Sir Leonard Sinclair as chairman, "to advise the Postmaster-General on the future place of the inland public telegraph services as part of the communication facilities of the United Kingdom", and he was seeking to encourage co-operation with private industry particularly in telecommunications. Help was being given by the Council for Industrial Design in standardization of telephone exchange equipment and telephone kiosks. Referring to the human problems of automation, after a tribute to the co-operation of the trade unions, Mr. Marples said that he had appointed the general secretary of the Union of Post Office Workers and the chairman of the staff side of the Post Office non-engineering Whitley Committee to the policy committee advising him on mechanization.

In replying to a question in the debate about cable-ships, the Assistant Postmaster-General, Mr. K. Thompson, said that the new two-way Atlantic cable to be laid in a few years, as a result of an agreement with Canada, would be a new plastic-covered cable developed by Post Office engineers and the cable company. British two-way rigid repeaters would provide sixty conversation channels in the single cable, compared with thirty-six in the present double cable.

MEDICAL USES OF IONIZING RADIATIONS

FOLLOWING on the publication of the British and American documents setting out the Hazards to Man of Nuclear Energy, the United Nations Organization set up a Scientific Committee on the Effects of Atomic Radiation. This Committee invited the International Commission on Radiological Protection and the International Commission on Units and Measurements to consider how best to arrive at reliable data for estimating the doses received by different parts of the human body—by individuals, and in the aggregate by large population groups—due to medical use of ionizing radiation. A study group, under the joint chairmanship of Prof. Rolf Sievert and Dr. Lauriston Taylor (chairmen, respectively, of the two International Commissions), decided to spread the work as widely as possible. It was divided among five groups of experts drawn from fourteen countries—Austria, Canada, Columbia, Czechoslovakia, Denmark, France, Germany, Italy, Norway, Sweden, Switzerland, the United Kingdom, the United States of America, and Uruguay.

The genetic hazard is of primary importance, and the data when accumulated will be used for assessing the significant dose per annum to the gonads of any population. A study group of the World Health Organization, which reported earlier this year, considered the possibility of registering systematically doses received by all individuals, but this proposal proved to be unrealistic. There would be too great a margin of error, and too great an expenditure of man-power and of money. There would be difficult legal and psychological consequences. There are, however, certain classes of persons, and certain routine procedures, for which, by a widespread expert sampling survey, sufficiently accurate records can be obtained. The undertaking is by no means a light one. The data available from half a dozen countries, now published in *Physics in Medicine and Biology*, **2**, No. 2 (1957), in some eighteen tables, prove to be difficult of collation; they disclose wide differences of estimated gonad dose. In Denmark and the United Kingdom it is given as about 25 mrad., in Sweden 40 mrad. and in the United States something nearer 100 mrad.

The group recommends an extensive survey, preceded by a pilot preliminary survey. It sets out the desiderata for obtaining uniformly reported information from various countries. These include classifications of age groups, the anatomical type of examination, the radiological type, and the gonad dose per examination for male, female and fœtus. In estimating the dose from the internal use of radionuclides, a factor should be introduced for 'parenthood expectation' for the average patient. It is of interest that, as had been found with other surveys, even the partial investigation so far carried out in Great Britain has already led to a reduction of the gonad dose by adoption of the recommendations included in the last report of the International Commission on Radiological Protection, and the evidence from expert measurement of the actual doses delivered. The means recommended to this end include protective devices for the gonads, a minimum film-focus distance, increased tube-housing protection, permanent filters of at least 2 mm. aluminium equivalent on all diagnostic tubes, the use of higher-voltage techniques, exposure counters

on all diagnostic equipment, and the use of image intensifiers.

Since the dose from diagnostic exposure outweighs that from all the other man-made sources, including that from fall-out, it is of great importance that it should be reduced by every means that does not at the same time minimize the great benefits that accrue. Radiotherapeutic dosage is of relatively far less significance.

It is recommended that basic studies should be continued; that in all countries where analysis of film records reveals a dose of more than a few per cent of natural background a detailed analysis should be made; that the sampling programme set out should be followed, after a pre-survey; that the team making the survey should be carefully trained, and make use only of approved dosimeters. Improved practice is confidently anticipated, and as indicated in the tables of Ardran and Crooks, should attain very considerable diminution of dose.

Prof. F. W. Spiers reports on the preliminary survey made in the United Kingdom, which expects to cover at least 5,000 examinations based on some 20,000 exposures, in three classes of hospital, and some clinics. Details of the instrumentation are given, together with forms for recording data so that transfer to punch cards is easy.

Ernest Rock Carling

GIANT MOLECULES

IT seems only yesterday that a professor of physical chemistry told me that a manufacturer had rung him up to ask, "What is this substance 'high polymers' we hear so much about? Can I make tubes of it?" Yet to-day it would be more to the point to ask what cannot be made of it. As for the question what Nature has made of it, answers of ever-increasing wonder and beauty pour out so fast that it is hard work giving them a fraction of the attention that is their due.

Our thoughts just now are much preoccupied, and excusably so, with those problems of atomic energy which betoken such a revolution in what has made up life hitherto that our future has become impossible to assess. All the same, it can be argued that in the long run, if there is going to be a long run, this is a more superficial view of things, because what is scarcely being noticed in the excitement is the quieter but far more pregnant revolution taking place simultaneously in our understanding of the molecular basis of life. Physico-chemically speaking, life is predominantly a question of the activities of chain-molecules in one form or another, and the science of man-made fibres, plastics, rubbers, and related products is an extrapolation therefrom—the lessons of Nature exemplified in a simpler but nevertheless very gratifying piece of 'homework'. The exploration of both these worlds, the old and the new, is now opening up so rapidly and excitingly that a reminder and synthesis such as that recently provided by *Scientific American* (**197**, No. 3; September 1957) in an issue devoted to high-polymer chemistry has a timely helpfulness that makes it doubly welcome. It comprises a set of nine articles by some of the acknowledged authorities in macromolecular studies, and they summarize an enthralling story most effectively.

The first five articles are chiefly about synthetic high polymers, and the other four are about macromolecules in biological structures. Mark starts off with a historical survey entitled "Giant Molecules", followed by Debye on "How Giant Molecules are Measured", Natta on "How Giant Molecules are Made", Tobolsky on "The Mechanical Properties of Polymers", and Oster on "Polyethylene"—the simplest chain-molecule of its kind, but extraordinarily versatile and fast becoming the commonest. Preston writes next on "Cellulose", Doty on "Proteins", Crick on "Nucleic Acids", and finally Schmitt on "Giant Molecules in Cells and Tissues". The level of presentation is uneven, with the elementary concept often explained at lengths which some readers might prefer devoted to more advanced parts, which are as a result rather glossed over. Some non-uniformity is almost unavoidable in articles of this sort, semi-popular and aimed at informing and interesting as wide a range of reader as possible. Taken together, these articles must certainly succeed in doing that: there is something for everybody, from the beginner to the specialist. The illustrations are particularly fine for teaching purposes, and there is a very useful bibliography.

Among the biological contributions which I, personally, found most enjoyable, was that by Doty, in which he tells of recent progress, by measurements of light scattering and optical rotation, in detecting the states of folding of synthetic polypeptides and proteins in solution. The former can change over, reversibly, from right-handed α-helices to randomly coiled chains, depending on *p*H and other conditions, and the transition is marked also by such characteristic changes in the optical rotation and rotatory dispersion that it is natural and seems well justified to apply the criteria to the globular proteins. The results indicate (as had already been suggested from X-ray and related studies) that such globular protein molecules as have so far been tested do indeed include α-helices in their make-up, to extents varying from 15 per cent in ribonuclease to 85 per cent in tropomyosin; and what is more, these proportions can be varied reversibly, and when the protein is an enzyme, activity goes up and down correspondingly. By implication, the same sort of adaptability of the intramolecular mixture of α-helical and randomly-coiled could account for the versatility of the γ-globulins and the formation of antibodies.

The main theme of Natta's article is the astonishing advances in the controlled building of high polymers that have been made within only the past few years by means of complex ionic catalysts, following Ziegler's production, for example, of unbranched polyethylene at atmospheric pressure and temperatures not much above 30° C. Vinyl polymers now run into molecular weights of millions, with their side-groups arranged at will in a so-called 'atactic', 'isotactic' or 'syndiotactic' sequence according as they occur at random on either side, all on the same side, or regularly distributed from side to side. Truly, as Natta says, "we can hardly begin to conceive how profoundly this new chemistry will affect man's life".

All this though, impressive as it is, is still child's play compared with the kind of thing discussed by Crick in his article on the nucleic acids. Deoxyribonucleic acid and ribonucleic acid have lately come to be recognized as the 'master race' of biological high polymers, in that apparently they alone can both transmit messages of heredity and afterwards dominate the business of protein synthesis. Recent

discoveries in bacterial genetics are more than fascinating; they are also perhaps rather disturbing, particularly in the light of the changes reported (J. Benoit, P. Leroy, R. Vendrely and C. Vendrely) to have been induced in White Pekin ducks simply by injecting into their peritoneal cavities soon after birth samples of deoxyribonucleic acid prepared from Khaki Campbell ducks. We can dimly see approaching a day when not merely bacteria but also higher animals and even human beings may have their transmissible characters moulded synthetically—a most alarming thought in some ways.

More dimly still, but now not nearly so as it appeared only a short while ago, a day can be envisaged when we may be able, in a process analogous with infection by a bacteriophage, or with any fertilization, to add a synthetic polynucleotide to a collection of synthetic substrates and thereby set going a little hive of 'synthetic life'.

There is something seriously wrong with dreams such as this, of course. Systems of proteins and nucleic acids and accessory molecules with nothing else can scarcely keep on thinking and asking questions about themselves and experimenting on themselves until they have at last succeeded in making themselves. Reason apart, the halt will surely be called by an ultimate indeterminacy principle which says that it is impossible to place the required components in their correct places all at the same time.

W. T. Astbury

EDUCATION FOR A TECHNOLOGICAL AGE

Delivering the ninth Hinchley Memorial Lecture to the Institution of Chemical Engineers on November 5, under the title "An Education for Our Times", Dr. R. P. Linstead, rector of the Imperial College of Science and Technology, London, said that the proportion of scientifically qualified men to the total employed in British industry as a whole is 0·8 per cent. The proportion varies, however, in the principal scientific industries from 10·9 per cent in nuclear power, 5·2 per cent in oil refining, to 2·7 per cent in chemical industry and 1·9 per cent in the aircraft industry. This vocational demand is likely to increase, but Dr. Linstead insisted first that science is an intellectual discipline of the first rank in its own right, and secondly that when the current very large requirement for scientists and engineers has been met by the necessary adjustments in our pattern of education, man will still have to meet his ultimate problems of virtue, civilized behaviour and the wise conduct of affairs. He argued that the study of pure and applied science provides an education peculiarly suitable to our times, and, limiting himself essentially to the higher education of boys from fifteen years upwards at school and university during the next decade, explored four questions.

The answer to the first, whether we have enough qualified engineers and scientists, is no, and Dr. Linstead said that in the next few years an increasing proportion of science specialists in the schools should be diverted from science to engineering when they reach the universities, and university departments of technology must be provided with the necessary facilities. In considering the second question, when their education should become specialized, he suggested that specialization in science and mathematics should not be pushed to the extent that a boy loses touch with the world of human studies and values, and he would like to see more flexibility in the general educational pattern, with some lightening of the requirements in factual scientific knowledge and, above all, search for intelligence. In discussing the third question, namely, whether the first-degree course should be longer, Dr. Linstead pointed out that this would involve additional capital expenditure of £15 million to £30 million, a large increase in recurrent expenditure and a hiatus in output for one year of at least 7,000 men. Rejecting this as impracticable, he urged that a real contribution could be made at the university-level by postgraduate instruction in the new types of scientific technology, where there is a real intellectual discipline to be mastered and not just a technique to be acquired.

In answer to his last question, whether scientists and engineers should be taught non-scientific subjects at the university, Dr. Linstead argued that any good system of education would provide a good product out of good material, against a good social background. In considering how far assistance can be given to students of science and technology to acquire a broader education and the attributes of leadership during their university career, Dr. Linstead suggested that, in general, compulsory and examinable non-scientific subjects should not be introduced into a three-year first-degree course. The college or university should, however, make a continuous and organized effort to provide facilities whereby a student can broaden his outlook, interests and experiences. In addition, certain types of non-scientific studies arise directly and, as it were, functionally out of a man's vocational interests and should very properly be studied in an organized way as part of them or side by side with them; for example, languages, some aspects of economics, and the history of science and technology. Finally, Dr. Linstead urged that the benefits of organized and compulsory classes in cultural subjects are limited, and in the last resort it is more important for a technological university to provide the facilities for a full life in human surroundings.

MANAGEMENT, GROUP CONFLICT AND THE SCIENCES

A penetrating analysis of management attitudes towards group conflicts in industry has been made by the Earl of Halsbury, managing director of the National Research Development Corporation (*Impact of Science on Society*, **8**, No. 3). Management is an act which occurs in opposition to some form of resistance, and to treat it as a problem in communications is inadequate. No mere verbal exposition of what a man does not want to do will make him want to do it. The fact that someone else wants it will not make him want it either. In some way the individual has to identify his wishes and hopes with those of others, with whose wishes and hopes his own were originally in conflict.

According to text-book expositions, change occurs because 'loyalty to the firm' binds management and workers together, and what is in the interest of the whole will ultimately seem to be in each individual's own interest, and will thus produce co-operation.

Unfortunately, great numbers of the human race are psychologically immune to any such approach.

Using an approach from social anthropology, Halsbury shows that within any one culture pattern a mosaic of variant sub-patterns can be seen, each with its characteristic ideology. The tyranny of words leads to over-simplification. People talk of 'the industrialist' and 'the trade-unionist' because grammar and syntax do not permit individuals to talk of them at all unless it is done in this way. To refer to 'the industrialist' or 'the trade-unionist' implies a homogeneity that does not exist. Some North American Indian language is needed which would enable one to treat as single nouns such complexes as the following: 'Church-going-factory-manager-with-strong-sense-of-public-service'; 'Free-trade-golf-playing-managing-director-believing-keep-out-of-my-way; 'Union-chairman-christian-naming-employers-confederation-operating-ancient-agreement-never-broken'; 'Vicariously-bitter-shop-steward-with-chip-on-shoulder'.

Treatises on managerial techniques which avoid reference to basic situations merely skim the surface of the subject. If social anthropology and industrial psychology are to be the nuclei of some future intellectual discipline which will transform and adjust human relations in accordance with human needs, then present indifference to the realities of 'intractable situations' must give way to an active interest in what ought to be the heart of the subject.

Tractable situations are, after all, tractable. If one knows what to do and has the will to do it, then an undesirable state of affairs will remedy itself in due course. A few pioneers will take the lead, and the rest of the community, giving time for imitation, will follow suit. In this way, factory welfare and managerial interest in workers' recreational and social life have spread throughout the industrial community. These are the mechanical contrivances of management. What is of paramount interest is why they are frequently ineffective. Why is one local ideology apparently unable or unwilling to copy what is manifestly successful elsewhere?

Group negotiations are, in practice, never carried on between groups. They take place between negotiators representing them. These negotiators occupy points on a spectrum stretching from the pure amateur at one end to the pure professional at the other. Their attitudes towards their status as negotiators must be a factor of some importance in determining the way negotiations proceed. They may or may not identify themselves with the group that they represent; they may or may not share its ideology. The professional will be less likely than the amateur to concern himself with group ideology and more likely to represent the group's views dispassionately on a consultant-client basis. The professional will be more anxious to calculate precisely what his client can hope to obtain, and then seek to obtain it.

An important feature of the professional's attitude is reluctance to give a point away on behalf of his client without instructions. If the client is a collective, a group, reference back for instructions is clumsy to the point of virtual impossibility, and professional reluctance to give way even on a trivial point may cause negotiations to be drawn out over a long period. The protraction of negotiations in this way may itself contribute to modifying group attitudes.

In a well-reasoned article, Halsbury shows that it is for sociologists to become the influential minority capable of switching attitudes over from one configuration to another. The social sciences are not only the youngest of the sciences; they also lack their popularizers. Of all the sciences, sociology should exercise the most powerful impact on society, just as introspection exercises the most powerful influence on minds.

DISTRIBUTION OF GLOBULIN PERMEABILITY FACTOR AND ITS INHIBITOR IN THE TISSUE FLUID AND LYMPH OF THE GUINEA PIG

By Prof. A. A. MILES, C.B.E., and D. L. WILHELM
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THE substances—like histamine, leukotaxine, plasmin and 5-hydroxytryptamine—variously held to be the initiators of the increased permeability of small blood vessels in inflammation are presumably released in the extravascular tissues. Their release in the blood itself is unlikely, because they would be removed too rapidly by the blood stream to have an effect confined to the inflamed region. The demonstration of a potent globulin permeability factor present in an inactive form (pro-permeability factor) in the serum of the guinea pig[1,2], rabbit[2–4], rat[2,3,5], man[3,6,7], and cat, dog, horse, ox and mouse (unpublished observations), while adding another candidate for the role of a natural endogenous mediator in the inflammatory response to injury, poses the problem of how, without the intervention of other permeability factors, the inactive form in the blood reaches the extravascular tissues for activation. We now have good evidence that in the guinea pig not only pro-permeability factor, but also the serum globulin inhibitor of permeability factor, are normally present in the tissue fluids.

In order to sample the tissue fluids without damaging tissue cells and thereby releasing intracellular material, we devised a method of intercellular perfusion; taking advantage of the fact that in the skin of the guinea pig's trunk, intracutaneously injected saline spreads mainly in the plane of the skin, without leaking through the epidermis or the fascia deep to the panniculus carnosus. The saline, with the materials it has gathered in its intercellular passage, can be harvested at a cut edge of skin at any required distance from the point of injection. The apparatus, designed to limit the perfusion to one direction only, is shown 'dissected' in Fig. 1. A piece of freshly excised skin, including all the layers down to the loose subcutaneous tissue immediately below the panniculus carnosus, is firmly clamped between

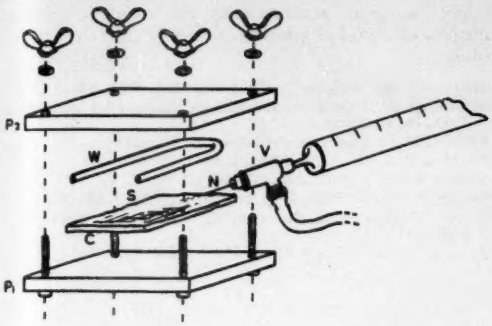

Fig. 1

two 'Perspex' plates, *P*1 and *P*2, which are kept 2–3 mm. apart by an elongated U-shaped piece of rubber-covered wire *W*. A strip of skin *S*, 10 mm. × 35 mm., is thus isolated and sealed except at one narrow cut edge *C* at the open end of the U-piece. At the other end of the strip a No. 26 gauge needle *N*, for the injection of physiological saline or Locke's solution, is inserted with its tip immediately below the dermis, and the skin clamped in position with its subcutaneous surface in contact with the U-piece. The U-piece is slightly notched at its mid-point to accommodate the thickness of the needle. The needle is mounted on a B–D double valve *V* No. 470*V*, which is used as a three-way tap, and to which is connected a tuberculin-type 1-ml. syringe and a reservoir of perfusion fluid.

Under syringe pressures of 3–4 atmospheres the saline flows along the skin strip to the open end of the U-piece, where it is sampled. Perfusion is greatly facilitated by adding 40 units of hyaluronidase to the first 0·5 ml. of perfusion fluid. In this concentration, the enzyme has no permeability factor activity and does not alter such activities in the perfusate. Its use also ensures that the tissue cells are forced apart during the injection with the minimum of trauma. Permeability factor activity is measured in terms of the diameter of the area of exudation of circulating pontamine blue (mean lesion diameter, Fig. 2) induced at the site of intracutaneous injection in the trunk of the guinea pig[8].

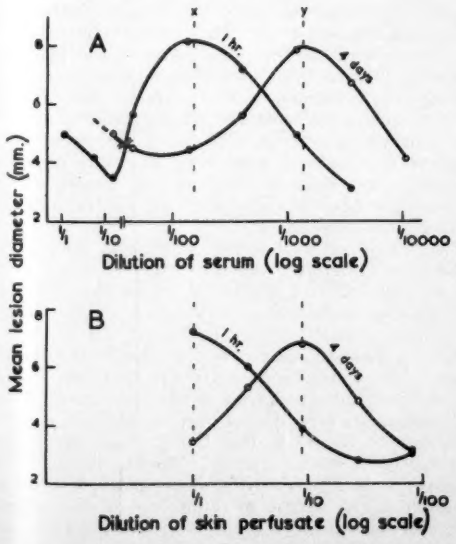

Fig. 2

Locke's solution perfusates of fresh skin, 10 mm. × 35 mm., tested 30 min. after harvesting, yield a permeability factor most of which appears in the first 3 ml., which contains about 90 effective blueing doses[1] (plasma contains[2] up to 20,000 such doses per ml.). The contribution of permeability factor from any intravascular plasma in the skin strip is negligible, because the perfusates are similar whether the skin is taken from animals exsanguinated after stunning, or from an area of skin of the flank previously perfused *via* the axillary artery with gelatin–Locke's solution until free of any visible traces of blood. Like the serum permeability factor, the intercellular permeability factor is inhibited by soya bean trypsin inhibitor and by the fraction of guinea pig serum containing inhibitor of permeability factor, but not by the antihistaminic drug, mepyramine maleate.

That it is obtained as permeability factor, and not in its inactive form, is to be expected, since the small quantity of intercellular fluid obtainable from 0·8 gm. of skin is diluted in 3 ml. Locke's solution; and it is a characteristic of the pro-permeability factor in undiluted serum that it is activated by simple dilution[1]. After ½–1 hr. at 22° C., serum permeability factor is activated in the dilution zone 1/50–1/1,000; in the zone 1/1–1/30, any activated permeability factor has been inhibited by the native inhibitor present; but when dilutions are held for four days at 4° C., zones of activation and inactivation shift into ten-fold higher dilutions (Fig. 2*A*). A readily elicited property, therefore, of the system is that a given dilution x first contains permeability factor and later loses it, whereas a higher dilution y is at first inactive and later acquires permeability factor activity. This property is displayed by skin perfusates (Fig. 2*B*)—indicating that the intercellular fluid contains inhibitor, and suggesting that the permeability factor has been activated from its inactive precursor.

The probable existence of intercellular pro-permeability factor is established by the examination of normal lymph. Lymph was harvested in healthy animals under urethane anæsthesia from the cervical ducts lying on each side of the trachea. Both native lymph after removal of the clot, and slightly heparinized lymph, have little permeability factor activity when tested intracutaneously in the undiluted state; but on dilution activation occurs within 30 min. at 22° C. in the zone 1/5 to 1/100. Moreover, on holding the dilutions at 4° C. for 1–2 days, the zone of activation shifts into higher dilutions, as it does in dilutions of serum and of intercellular perfusates (Fig. 2). The permeability factor in lymph is inhibited by soya bean trypsin inhibitor and by guinea pig serum permeability factor inhibitor, but not by mepyramine. Since the lymph could be harvested with rigid precautions against contamination with shed blood, the results, unlike those with the skin strip, are not open to the criticism that traces of intravascular plasma permeability factor may have been present in the perfusates.

It appears, therefore, that the proteins constituting the pro-permeability factor/inhibitor system of the blood pass normally into the intercellular fluid

and rejoin the circulation *via* the lymph. There are thus no topographical obstacles to an immediate, local, extravascular activation of permeability factor in the appropriate pathological circumstances; and there is no need to postulate additional mechanisms whereby serum pro-permeability factor is brought into the tissues at the time of injury. As we have noted before[2], the ready activation of serum permeability factor by simple dilution suggests that it is activated *in vivo* by relatively mild means; but the presence of the pro-factor in both lymph and tissue fluids is inconsistent with the notion that permeability factor is activated as the result of actual dilution of exuded plasma proteins in the tissue fluids.

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SPECIES-SPECIFIC DIFFERENCES IN FREE AMINO-ACIDS AND PEPTIDES IN SEA-URCHIN EGGS AND EMBRYOS (PURE SPECIES AND HYBRIDS)

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STUDIES of amino-acid metabolism in sea-urchin development have been carried out on *Strongylocentrotus purpuratus*[1,2] and *Paracentrotus lividus*[3,4]. In both species it was found that free glycine is present in large quantities in the developing eggs, and that distinct quantitative changes of the free amino-acids occur in the course of morphogenesis. Recently, in connexion with experiments devoted to studies of protein metabolism in sea-urchin hybrids, we used the technique of paper partition chromatography to study the amino-acids at various developmental stages of *Paracentrotus lividus*, *Arbacia lixula* and *Sphaerechinus granularis*. These species belong to three different families and, according to our chromatographic results, differ from each other in their patterns of free ninhydrin-positive substances. This is a preliminary report on such species-specific differences detected on our two-dimensional chromatograms and on the corresponding chromatographic patterns in the hybrids *Paracentrotus* ♀ × *Arbacia* ♂ and *Sphaerechinus* ♀ × *Paracentrotus* ♂.

Materials of all three sea-urchin species were collected from the Bay of Naples in March and April, 1957. Only fresh specimens were used for fertilization. The fertilized eggs were kept at 18° C. until the desired stages of development were reached. The latest stage examined in the present study was the pluteus shortly before feeding. In addition, the amino-acid content of the unfertilized eggs was also determined. These eggs were usually obtained from that female which had been used for the fertilization.

The procedures of preparing the amino-acid extracts are as follow: a measured volume of culture suspension containing on the average 10,000 eggs was first concentrated by centrifugation. The sedimented eggs, after removing the sea-water very carefully, were homogenized in a microhomogenizer and extracted in 80 per cent methanol. After centrifuging the sample again, the supernatant was applied with a fine pipette to a Whatman No. 1 filter paper (28 cm. × 46 cm.). A second extraction was carried out, and the supernatant again transferred to the sheet. The paper was first run in 70 per cent *n*-propanol (ascending) and then in water-saturated phenol (descending). After the phenol run the spots were made visible by spraying the sheet with 0·5 per cent ninhydrin in 96 per cent ethanol, followed by heating at 90° C. for 15–20 min.

Three typical two-dimensional chromatograms of the sea-urchin species investigated are reproduced in Fig. 1. In *P. lividus* the following free amino-acids, amides and peptides have been found in eggs and embryos of different stages: aspartic acid, glutamic acid, serine, glycine, threonine, tyrosine, α-alanine, β-alanine, glutamine, cystine, ornithine, lysine, asparagine, arginine, histidine, proline, valine (and/or methionine), leucine (and/or *iso*leucine) and five peptides (Fig. 1, *A* and Table 1). In accordance with the results reported by earlier authors[1,3,4], glycine was found to occur in abundant quantities with α-alanine next to it. The concentration of other free amino-acids is very low. Among the peptides, spot No. 20 has been identified as glutathione by adding pure substance to the extract. Spot No. 21 gives a brown, and spot No. 22 a green-blue, colour with ninhydrin. Since both spots disappear from the extract after acid hydrolysis, they are probably peptides, too. Because of their low concentrations we have not been able to carry out further analyses on these two substances.

The free amino-acid picture of *A. lixula* (Fig. 1, *B*) looks quite different from that of *P. lividus*. First, the concentration of glycine is by no means higher than that of the other amino-acids detectable in the free form. Second, spots No. 21 and No. 22, which showed a constant occurrence in the *Paracentrotus*-extract, have never been traced in this species. Third, the *Arbacia* chromatogram is characterized by the appearance of a new spot of particularly high concentration (spot No. 17 in Fig. 1, *B*). Considering that this substance reacts readily with ninhydrin and is resistant to acid hydrolysis, it is assumed to be an amino-acid. With the solvents used in the present study its R_F values (0·48 in 70 per cent *n*-propanol, 0·74 in water-saturated phenol) are very close to

those of methionine sulphoxide, and β- and γ-aminobutyric acid. It is obviously not methionine sulphoxide, because no methionine sulphone was formed by oxidation with hydrogen peroxide. It behaves very similarly to the substance 'fast-aminobutyric acid' described by Dent in plant extracts and in blood and urine[6]. Our investigations to ascertain the chemical nature of this spot are still in progress.

The chromatogram of *S. granularis* is similar to that of *P. lividus* in so far as glycine occurs in enormous quantities, and spot No. 17, which is characteristic for *A. lixula*, was also not recorded in this species. However, a closer examination of the chromatogram revealed another new spot which is apparently specific for *Sphaerechinus*, and has been found in extracts in both unfertilized eggs and developmental stages ranging from blastula to pluteus (spot No. 23 in Fig. 1, *C*). The R_F values (0·41 in 70 per cent *n*-propanol and 0·64 in water-satured phenol) suggest this substance to be β-alanine. Its ninhydrin colour is, however, not blue, but purple. It cannot be citrulline, because no yellow spot was formed by spraying the paper with a 1 per cent solution of *p*-dimethylaminobenzaldehyde. The fact that the unknown compound disappeared from the extract upon hydrolysis indicates that it is a peptide. This point was confirmed by eluting the material from the area and subjecting the eluate alone to hydrolysis. The hydrolysate was shown to contain chiefly α-alanine with a moderate amount of glutamic acid and a trace of aspartic acid. Another substance (spot No. 24 in Fig. 1, *C*, and unknown in Table 1) has been traced also only in *S. granularis*. It gives a very faint spot, and was not investigated further by us.

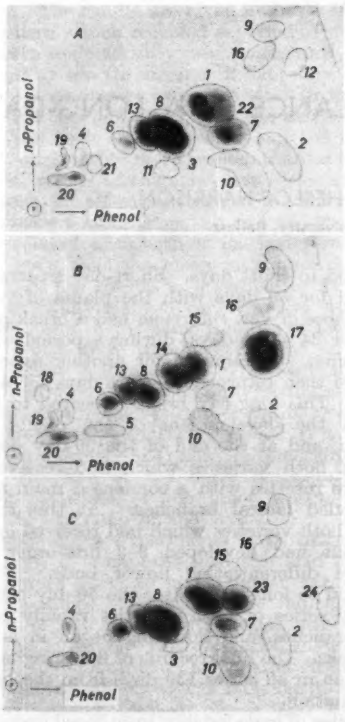

Fig. 1. Free ninhydrin-positive substances in methanol extracts of sea-urchin eggs and embryos. The chromatograms are not from corresponding stages, but the amino-acid pattern of each species remains largely unchanged during development. *A*, *Paracentrotus lividus* (10, 178 unfertilized eggs); *B*, *Arbacia lixula* (20, 772 early pluteï); *C*, *Sphaerechinus granularis* (6,266 unfertilized eggs). 1, α-Alanine; 2, Arginine; 3, Asparagine; 4, Aspartic acid; 5, Cystine; 6, Glutamic acid; 7, Glutamine; 8, Glycine; 9, Leucine (and/or *iso*leucine); 10, Lysine; 11, Ornithine; 12, Proline; 13, Serine; 14, Threonine; 15, Tyrosine; 16, Valine (and/or methionine); 17, 'Fast-aminobutyric acid'; 18–23, Peptides; 24, Unknown spot.

Table 1. Free Ninhydrin-positive Substances in Methanol Extracts of Sea-urchin Eggs and Embryos*

	Paracentrotus lividus and *Paracentrotus* ♀ × *Arbacia* ♂	*Arbacia lixula*	*Sphaerechinus granularis* and *Sphaerechinus* ♀ × *Paracentrotus* ♂
α-Alanine	+	+	+
β-Alanine	+	−	−
Arginine	+	+	+
Asparagine	+	−	+
Aspartic acid	+	+	+
Cysteine	−	−	+
Cystine	+	+	+
Glutamic acid	+	+	+
Glutamine	+	+	+
Glycine	+	+	+
Histidine	+	−	−
Leucine (*iso*Leucine)	+	+	+
Lysine	+	+	+
Ornithine	+	−	−
Proline	+	−	−
Serine	+	+	+
Threonine	+	+	+
Tyrosine	+	+	+
Valine (Methionine)	+	+	+
'Fast-aminobutyric acid'	−	+	−
Peptide 1	+	+	+
Peptide 2	+	+	+
Peptide 3 (Glutathione)	+	+	+
Peptide 4	+	−	−
Peptide 5	+	−	−
Peptide 6 (Tripeptide)	−	−	+
Unknown	−	−	+

* Those substances, which are listed in the present table and not shown on chromatograms in Fig. 1, give very faint spots, and have been observed only occasionally.

In all three types of eggs the patterns of free amino-acids, in spite of their quantitative changes, remain largely constant during development. (Results concerning the quantitative changes of free amino-acids and peptides during the development of both parental species and the hybrids will be published elsewhere.) Thus, the specific differences described above can be noted in every stage of development. Table 1 is a summary of all free ninhydrin-positive substances, the existence of which has been so far established in the three sea-urchin species examined by us.

Further efforts were made to analyse the amino-acid composition of the proteins denatured during the methanol extraction. After pipetting out the supernatant for chromatographic separation, the protein precipitates were suspended in 6*N*-hydrochloric acid for hydrolysis at 110° C. for about 12 hr. In contrast to the findings quoted above, the protein hydrolysates of all three sea-urchin species are strikingly similar in their amino-acid constituents. These consist of aspartic acid, glutamic acid, serine, glycine, threonine, α-alanine, tyrosine, lysine, arginine, histidine, proline, valine (and/or methionine) and leucine (and/or *iso*leucine). It is of particular interest that glycine, which was found to be present in unusually large quantities in the methanol extracts of both *Paracentrotus* and *Sphaerechinus*, shows a relatively low concentration in their protein hydrolysates. In *Arbacia* the substance corresponding to spot No. 17 has never been located on the hydrolysate chromatogram. In other words, the species-specific differences described for the free amino-acids are not reflected

in the amino-acid composition of the proteins. This may indicate that differences of specific proteins in the sea-urchin egg, as demonstrated by serological studies[6], probably lie on the structural level.

The chromatographic patterns of the corresponding substances in the two hybrids studied show an entirely maternal character (compare Table 1). It may be added that these hybrids are very different in their developmental behaviour. The development of *Paracentrotus* ♀ × *Arbacia* ♂ is normal and maternal until the beginning of gastrulation (like many interspecific hybrids). Then the development stops and the inhibited gastrulæ die. On the contrary, *Sphaerechinus* ♀ × *Paracentrotus* ♂ develops normally to the pluteus stage, which shows, as it is well known, maternal and paternal character in the skeleton[6]. In spite of this intermediate behaviour the chromatographic pattern is completely maternal.

The relationship between protein metabolism and morphogenetic development has been demonstrated to be a complicated one[7]. The fact that the amino-acids, in spite of their high concentration in the free, non-protein fraction, are either not detectable or occur only in unproportionally minute quantities in the proteins, suggests that they serve some special purposes rather than being merely building stones of proteins. In the *S. purpuratus* egg there is evidence that certain amino-acids play a part in the energy metabolism, while others play a part in the osmoregulation[8]. It is uncertain if this conclusion also holds true for the other sea-urchin species and for the hybrids. The function of the new spots found in *Arbacia* and *Sphaerechinus* reported here for the first time is entirely unknown. We shall now try to ascertain their metabolic roles. Given a more complete knowledge about these substances it would be possible to find out to what extent such specific differences in the amino-acid patterns are responsible for the developmental potencies of the hybrid embryos[6].

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PHOTOPERIOD, AUXIN AND SEX BALANCE IN A LONG-DAY PLANT

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REPORTS on the effects of photoperiod on sex expression in diclinous flowering plants have mostly suggested that photoperiodic régimes which promote early or abundant flowering tend, initially at least, to enhance femaleness, the response being apparent in the production of a greater proportion of pistillate flowers, or in intersexuality in staminate ones[1]. Comparable effects can be induced by treatment with synthetic auxins in various monoecious Cucurbitaceae[2–5] and in the dioecious *Cannabis sativa*[6]. The present article reports corresponding results in a long-day plant with monoclinous flowers, *Silene pendula* L.

Seeds of two cultivars, *ruberrima* and *compacta* (obtained from Messrs. Thompson and Morgan, of Ipswich), were germinated in a mixture of sand and peat, and the seedlings transplanted at a height of 4–5 cm. to individual pots, where they received on alternate days a 15-ml. ration of a balanced nutrient solution containing about 200 p.p.m. nitrogen. The plants were grown throughout in a greenhouse with night temperature regulated between 20° and 22° C. Short-day treatment was given by enclosing the plants in ventilated dark cabinets from 5 p.m. until 9 a.m. daily. Plants receiving long days were exposed to natural daylight with supplementary illumination at 300–400 ft.-candles from a mercury vapour source to give a total light period of 21–22 hr.

Matched groups of eighteen plants of var. *ruberrima* and ten of var. *compacta* were grown to an age of 40 days in long days, and half of each group then transferred to short days. Short-day treatment was continued for 50 days with the plants of var. *compacta*. Those of var. *ruberrima* had a break of 4 long days after 24 short days, during a period when the dark cabinet was required for another experiment; they were then returned to short days for a further 22 days. This long-day break appeared to have no effect on the development of the plants of var. *ruberrima*, and at the end of the 50-day period, all plants of both varieties which had received short days were rosettes with a condensed main axis and no extended lateral branches. At this time, the series of both varieties which had received long days throughout had developed 6–9 first-order laterals and were differentiating flower buds. Following restoration to long days after the 50-day period, the short-day series of both varieties rapidly produced lateral branches, and flowering began in all within three weeks. The final records of flowering behaviour were taken in all series 130 days from the beginning of germination.

Estimates of male fertility were based upon samples of 100 randomly collected flowers from each plant. In male-sterile flowers, development of the androecium may be arrested at any stage from the emergence of the primordia to the end of micro-sporogenesis. However, since the formation of fertile pollen is marked by a change of the anther colour from yellow to purple, male sterility may be recognized without resort to microscopy even when its onset is delayed until the completion of meiosis. Every stamen in

Fig. 1. (*a*) Normal flower (calyx and corolla removed) from a plant of *Silene pendula* var. *compacta* flowering in long days (21–22 hr. light) after an interlude of 50 short days (8 hr. light). Anthers of the first flush are shedding pollen; those of the second group have not yet dehisced, and the styles have not yet emerged from the corolla tube. (× *c.* 3). (*b*) Male-sterile flower at a corresponding stage from a plant of *S pendula* var. *compacta* grown throughout life in long days,. showing the contabescent anthers and greatly enlarged gynœcium. (× *c.* 3)

each flower of the sample was examined, so that the proportion of sterile stamens in a total of 1,000 was recorded. The results are given in Table 1. Whereas in the plants which received a period of exposure to short days male fertility was consistently high, all the plants grown throughout in long days were male sterile to a greater or lesser extent. In none of the totally male-sterile flowers were the anthers exserted beyond the limb of the corolla, and the ovary was usually considerably more swollen than in the perfect flowers of plants of the short-day series at the time of anthesis, an effect reflected in the enlarged calyx of the young flowers (Figs. 1 *a* and *b*). Male sterility was associated also with a marked diminution of corolla size; thus the mean maximum diameter of the limb of the corolla in a sample of forty flowers from a short-day plant of var. *compacta* was 20·06 ± 0·26 mm., and in the same number of totally male-sterile flowers from a long-day plant of the same variety 12·99 ± 0·22 mm. The fully male-fertile flowers produced on the long-day plants were mostly the distal ones in each partial or complete dichasium. Like those of the short-day plants (Fig. 1*a*) they were protandrous, the anthers emerging in two flushes, the five of the outer antepetalous whorl followed by those of the inner whorl, 50–60 hr. before the exsertion of the styles.

In preliminary experiments with auxin, general applications of α-naphthaleneacetic acid in aqueous solution were given to plants under various photoperiodic régimes. Though clear indications were obtained of the induction of male sterility under conditions in which control plants showed normal fertility, the concentration of α-naphthaleneacetic acid producing this effect was sufficient to cause high mortality among treated plants and severely to depress the general vigour of survivors. With plants showing general debility, it did not seem justified to conclude that loss of male fertility was a specific auxin effect. In further experiments a specific effect was demonstrated by limiting treatment to particular branches of vigorously growing plants during the period of flower differentiation.

Table 1. Mean Numbers of Sterile Anthers per Sample of 100 Flowers per Plant in Two Varieties of *Silene pendula* under Two Photoperiodic Régimes

Long-day and short-day treatments as in text

	Long-day	Short-day
Var. *ruberrima* (9 plants per series)	522·3 ± 56·0	6·67 ± 2·14
Var. *compacta* (5 plants per series)	427·8 ± 95·8	13·00 ± 1·85

In an experiment with var. *compacta*, two vigorous 90-day old plants were transferred to long days after exposure to fifty short days. Lateral shoots began to extend after ten long days, and at this stage, at the onset of flower differentiation, three pairs of basal leaves of five shoots in one sector of each plant were treated with lanolin paste containing α-naphthaleneacetic acid at 0·5 per cent, each leaf receiving about 0·1 gm. of the paste. The flowering behaviour of these shoots was followed during the subsequent four weeks, and the over-all male fertility compared with that of other floriferous untreated branches of the same plants. The striking effect of α-naphthaleneacetic acid in depressing male fertility is apparent from Table 2.

Table 2. Effect of α-Naphthaleneacetic Acid on Male Fertility in *Silene pendula* var. *compacta*

Sterility of anthers in all flowers formed on five treated laterals of each plant compared with that in a sample of 100 flowers from untreated branches of the same plant. Treatment details as in text

Plant No.	Untreated laterals per cent sterile anthers (100 flowers)	Treated laterals	
		No. of flowers	per cent sterile anthers
*SC*7	1·2	27	84·8
*SC*15	1·1	21	75·7

In a similar experiment with var. *ruberrima*, treatment was restricted to one outgrowing lateral, the auxin paste being applied to the lower surfaces of successive pairs of leaves as they opened. Flowering was retarded and somewhat reduced by this treatment, but again an unequivocal effect upon male fertility was apparent, as may be seen from the records of the individual plants in Table 3.

A feature of auxin-induced male sterile flowers of both varieties was the remarkable precocity of development shown by the gynœcium. Frequently the styles were exserted and the stigmas became receptive before the corolla opened (Fig. 2), and it was not unusual for the corolla to fail to expand altogether. Flowers of this type were mostly female-fertile, producing a normal crop of seed when pollinated artificially. In a few instances auxin

Fig. 2. Intact male-sterile flower of *S. pendula* var. *ruberrima* from an auxin-treated branch of a plant flowering in long days after an interlude of 50 short days, showing the precocious emergence of the styles, the arrested corolla, and the inflated calyx surrounding the abnormally enlarged ovary. (× *c.* 2·5)

Table 3. Effect of α-Naphthaleneacetic Acid on Male Fertility in *Silene pendula* var. *ruberrima*

Sterility of anthers in all flowers formed on the single treated lateral in each plant compared with that in a sample of 100 flowers from untreated branches of the same plant. Treatment details as in text

Plant No.	Untreated laterals per cent sterile anthers (100 flowers)	Treated laterals No. of flowers	Treated laterals per cent sterile anthers
*SR*5	0·9	5	98·0
*SR*7	0·0	4	100·0
*SR*13	0·3	5	100·0
*SR*15	0·9	2	100·0
*SR*17	1·3	2	100·0

treatment through the leaves resulted in parthenocarpy, capsules being formed directly without opening of the flower and without pollination.

Of the small numbers of fully or partly male-fertile flowers formed on the auxin-treated lateral branches in the experiment with var. *compacta*, most showed strong protogyny, the styles being exserted two to four days before the dehiscence of the anthers. Flowers of the untreated branches of these plants were regularly protandrous.

Cytological aspects of the male sterility induced in *Silene pendula* by photoperiodic and auxin treatments will be described elsewhere; here it is sufficient to state that morphologically and histologically the effects produced through the two agencies are very much alike. The similarity of the reaction suggests that the influence of photoperiod on sex balance may be exerted through the native auxin metabolism of the plant during the period of flower differentiation, a possibility already indicated by work with short-day species[1,5,7] but still without direct proof based upon auxin assay.

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'PURITY' OF GELATIN AS A PROTEIN

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BAILEY has recently written[1] that, because of the use of newer techniques, the "most respectable" proteins are turning out to be mixtures. I wish to describe experiments which bring gelatin within this category.

It is generally believed that, neglecting inorganic impurities, gelatin represents a fairly 'pure' protein. This assumption is implicit in much research work on gelatin[2]. Eastoe, for example, regards gelatin as a purified form of collagen[3], the main criterion of purity in this case being constancy of amino-acid composition.

It has long been known that gelatin contains small quantities of proteins similar to albumin. Thus, by heat coagulation, Sheppard[4] was able to isolate small quantities (about 0·5 per cent) of a protein which he identified as being similar to albumin. In later work[5], Sheppard described a process for removing albumin ($\ll$ 1 per cent) from gelatin by solvent precipitation, for example, with acetone. Similar results are described by Stainsby[6] for ethanol fractionation. Maron has described[7] the isolation of an albumin-like protein (0·3 per cent) by treatment of gelatin with active charcoal.

Following the application of Sheppard's technique of heat coagulation[4] to samples of gelatin, we wished to use some less-destructive procedure for assessing the effects of any purification methods which might be suitable for gelatin. The first procedure attempted was chromatography of the whole (unhydrolysed) protein on ion exchange resin columns as described by Boardman and Partridge[8]. The following work applies to high-grade lime-processed gelatins with iso-electric points[9] in the region of *p*H 5. The resin used was 'Amberlite *XE*-97', 200–400 mesh in a column 16 cm. high and 1 cm. diameter. Runs were carried out either on 1 ml. of 0·5 per cent w/v gelatin solution (= 5 mgm.) for analytical purposes or 2 ml. of 2·5 per cent w/v gelatin solution (= 50 mgm.) for preparative purposes. Buffer was passed through the column at 4 ml./hr. and 1 ml. fractions were collected on a Locarte fraction collector. Analysis was usually carried out by acid hydrolysis of the fractions, followed by a colorimetric ninhydrin procedure[10] for total amino-nitrogen. Occasionally, a modified biuret procedure[11] was also used.

When the resin was buffered at *p*H 7 or *p*H 6 (McIlvaine buffer), and the column was eluted at this *p*H, the major part of the protein was fairly rapidly removed from the column, as shown in Fig. 1 (left). When the *p*H of the resin and of the eluting buffer was reduced to 5·5, a much lower peak was observed (Fig. 1, right). The remainder of the protein was not eluted at *p*H 5·5 up to 250 fractions either at 25° C. or 35° C., nor did shortening the resin column to 5 cm. allow it to be eluted. It must

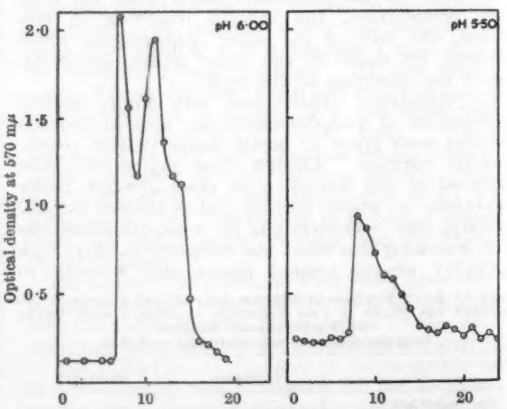

Fig. 1. Behaviour of gelatin on a 16 cm. × 1 cm. column of 'Amberlite *XE*-97' at different *p*H's

be concluded that it is very firmly bound by the resin at this *p*H.

Changing the *p*H of the buffer to 6 or 7 after elution of the first peak did not produce a great effect because of the considerable buffering capacity of the resin. However, if, after elution of the peak mentioned, the run was continued with 0·1 *N* sodium hydroxide at 35° C., the *p*H of the effluent rose rapidly to 8 and simultaneously the remainder of the protein began to come off the column (Fig. 2).

This procedure, therefore, has divided the gelatin into two fractions. It is estimated that the total ninhydrin colour produced by the first peak corresponds to about 15 per cent by weight of the gelatin. The protein in this peak may be isolated by pooling the fractions, dialysis and precipitation with ethanol. In two experiments, the yield of protein obtained in this way was 15 and 19 per cent, respectively. The isolated protein was examined qualitatively by paper chromatography. This showed that the protein resembled serum albumin and differed from gelatin in the following respects. It contained no hydroxyproline and only a low concentration of glycine. Tyrosine was easily detectable. Hydroxylysine was absent. Cystine was only present in traces as it is largely destroyed by the liming treatment in gelatin manufacture[13] (Fig. 3).

The question of tyrosine content is an interesting one. According to Eastoe[3], the tyrosine content of gelatin is very variable and may represent the extent of contamination by another protein. This view is shared by Harkness *et al.*[13]. I have carried out tyrosine determinations by direct measurement in 0·1 *N* sodium hydroxide in the ultra-violet[14]. The tyrosine content of the group of gelatins studied varied from 0·31 to 0·54 per cent on an air-dry basis. The tyrosine content of the protein eluted at *p*H 5·5 was not accurately determined, but was about 3 per cent; the protein eluted at *p*H 8 contained very little detectable tyrosine (lower limit of detection 0·01 per cent). This would imply that the concentration of the other protein in the gelatins studied varied from 10 to 18 per cent.

The implications of such a finding are many. It may be that either an inter-protein complex or a definite impurity of possibly variable concentration

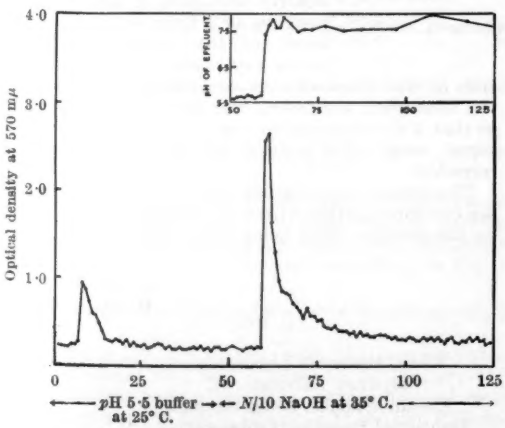

Fig. 2. Elution of two peaks from 5 mgm. gelatin. The upper portion (inset) shows the *p*H changes in the effluent when the sodium hydroxide run begins

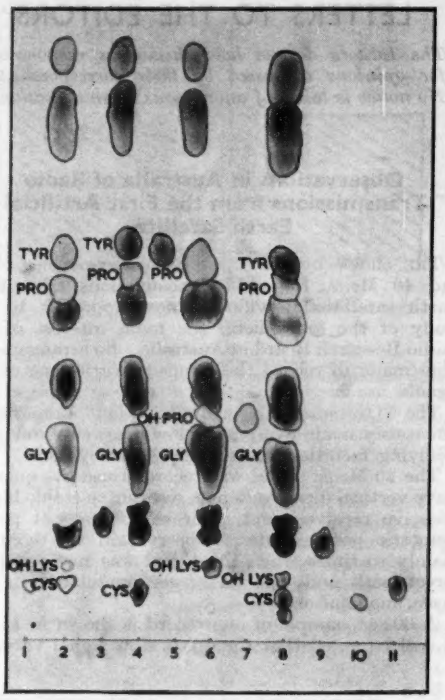

Fig. 3. Paper chromatogram of various protein hydrolysates (descending, Whatman No. 1, butanol-acetic acid). Detection by ninhydrin

1, Cystine; 2, protein eluted at *p*H 5·5; 3, lysine; 4, blood albumen (B.D.H.); 5, tyrosine; 6, gelatin; 7, hydroxyproline; 8, heat-coagulated protein, according to Sheppard (ref. 4); 9, lysine; 10, cystine; 11, hydroxylysine. Zones shown dotted are very faint

is present. In the latter case, such studies as N-terminal amino-acid groups, gelatin structure and amino-acid sequence may be regarded as of doubtful validity. The present conceptions of other properties such as surface activity, adsorption and viscosity of gelatin solutions may also be influenced by the new evidence. A discussion of such implications as well as a more detailed account of the present work will be given elsewhere.

Technical assistance in the present work was given by Mrs. B. Ormerod and Miss M. E. Bell. I should also like to thank Mr. A. G. Ward, director of research at the British Gelatine and Glue Research Association, and members of his staff for valuable discussions.

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LETTERS TO THE EDITORS

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Observations in Australia of Radio Transmissions from the First Artificial Earth Satellite

The choice by the U.S.S.R. of frequencies of 20 and 40 Mc./s. for radio transmissions from their Earth satellites provided a new approach to the study of the ionosphere, the main interest of the Radio Research Board in Australia. So arrangements were made to record the intensity variations of the signals.

The Overseas Telecommunication Commission generously made available a low-noise site and good receiving facilities at Bringelly, near Sydney.

The 20 Mc./s. signal was recorded using a quarter-wave vertical dipole antenna, a sensitive stable highly selective receiver, and a Brown high-speed potentiometric pen recorder. Observation was confined mainly to times when the signal was received by a direct path and was no longer modulated by the $\frac{1}{2}$ sec. modulation.

A 60-sec. sample of one record is shown in Fig. 1. It will be noted that there is a slow signal variation

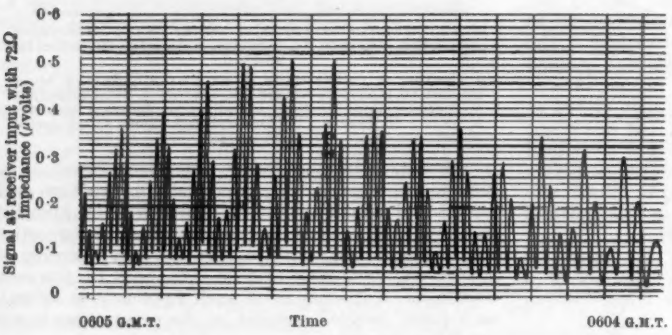

Fig. 1. Strength of 20 Mc./s. signals from satellite *a*1957 recorded at Bringelly, N.S.W., Australia, on October 19, 1957, at 0604–0605 G.M.T.

with sensibly constant period of the order of 5 sec. and a faster deep fading of variable periodicity.

The faster fading-rate varies according to a regular pattern which is shown plotted in Fig. 2 for three close transits. It can be seen that the rate passes through a minimum which occurred always to the south of the observing station. There are also points of inflexion in the curves which occur at times when the satellite is near to the position of closest approach to the station as deduced from Doppler shift measurements.

The south to north transits were at a height of approximately 500 km. and from north to south they were at approximately 900 km. For the north to south transits only one record has been found which shows both sides of the minimum.

The minimum appears to occur when the satellite position is such that the propagation of the wave is nearly perpendicular to the direction of the Earth's magnetic field; but more accurate orbital information than is at present available is needed to establish this precisely.

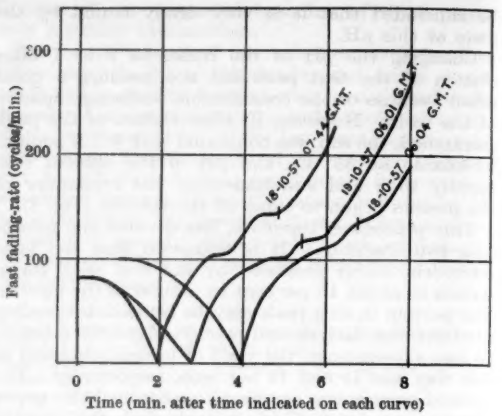

Fig. 2. The fast fading-rate of the 20 Mc./s. signal of satellite *a*1957 as a function of time during south to north transits. Vertical stroke, time of nearest approach to station

Similar effects appear to be present on 40 Mc./s. records which were made simultaneously with the 20 Mc./s. measurements; but the recordings were made with less satisfactory equipment. The slow fading pattern, because of its regularity, is considered to be a feature of the transmission, possibly due to rotation of the satellite. There seems little doubt that the fast deep fading is due to interference between the ordinary and extraordinary components as the respective received phases vary due to a combination of variation in path difference and Doppler frequency shift difference for the two components. The relative magnitude of the two effects has not yet been computed.

In addition, the depth of the beats has enabled calculation of the relative strengths of the two components as a function of time and hence of the relative absorption in the ray paths. Due to attenuation of the extraordinary component the fading at the time when the fading rate is a minimum is small so that if the attenuation was high or the transmitted signal weak, this portion of the curves was not recorded.

Theoretical examination and detailed computation are continuing in anticipation of accurate information on the satellite orbit being obtained.

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Propagation of Radio Waves from Cosmical Sources

When a radio wave passes through an un-ionized medium its ray path is rectilinear. On passing through such ionized layers, which usually surround the Earth, its trajectory is satisfactorily determined by Snell's law :

$$\mu\rho \sin i = \rho_{\parallel} = \sin i_0 = \text{constant} \qquad (1)$$

which is valid for any point of the ray path. For the sake of simplicity the radius of curvature ρ_m of the maximum of electron density is taken as the unit of length. The significance of the parameters used follows from Fig. 1.

According to (1) and Fig. 1, the rectilinear part of the ray path must be tangential to the sphere defined by $\rho_{\parallel}$, everywhere in the un-ionized medium. Thus a ray which passes through spherical ionized layers of the same centre of curvature O is turned about this centre of curvature by the angle R (Fig. 1).

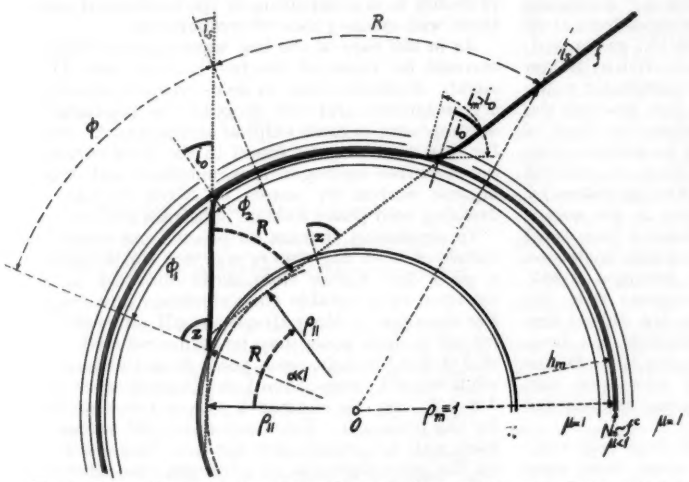

Fig. 1. Parameters used in formulæ 1 and 2. f is the wave frequency, f^c the critical frequency of the layer,

$$\mu = \sqrt{1-\left(\frac{f^c}{f}\right)^2} \text{ and } \rho = \frac{6{,}400 \text{ km.} + h}{6{,}400 \text{ km.} + h_m}$$

, h and h_m being in km.

For this angle of refraction R the following simple formula has been derived[1] :

$$R = \frac{90^\circ}{\pi}\left(\frac{f^c}{f}\right)^2 \frac{\sin i_0}{\cos^3 i_0} \cdot \sigma \qquad (2)$$

where again $\rho_m = 1$, i_0 is the angle of incidence of the rectilinear parts of the ray path, related, however, to this level $\rho_m = 1$, and the equivalent thickness σ of the layer is to be determined according to Fig. 2.

Formula 2 is valid for $\frac{f^c}{f\cos i_0} < 0{\cdot}4$ and $\Delta < \rho_m/5$.

For $f^c/f \cos i_0 > 0{\cdot}4$ the true refraction is greater than the calculated one, and it increases to infinity; this case, dealing with a perpetual propagation of radio waves around the Earth along one of the two different levels of the ionosphere, has been treated previously[2].

The refraction formula 2 has the advantage that it depends only upon the total content of all free electrons present in the layer, but not upon the irregularity in electron distribution with height, which up to the present time has made the calculation of refraction uncertain. Formula 2 is valid even for sharp gradients of electron density, and for parabolic types of layer, $\sigma = \frac{4}{3}\Delta$, it goes over into Bailey's formula[3].

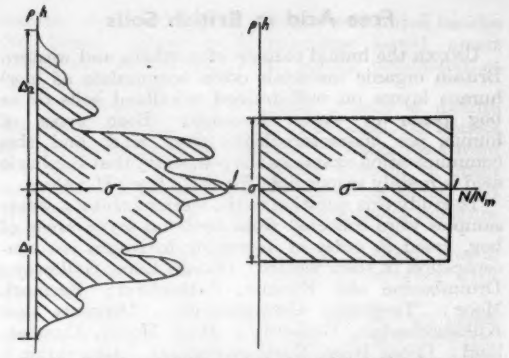

Fig. 2. The true and the equivalent layer, introduced in order to avoid discrepancies that could appear as the electron density is usually expressed in cm.[3] while the introduced unit of length is ρ_m. In this equivalent layer having the same contents of electrons and the same N_m, the electrons are squeezed together in order to form a layer of uniform electron density (N_m). The thickness of this equivalent layer $\sigma > 1$ is to be introduced into formula 2

The theoretical result, mentioned above, is in good agreement with experimental results obtained from the signal records of the first artificial satellite. The angular distance of the satellite $\varphi + R$ was determined from formulæ 1 and 2 and Fig. 1 as follows :

$$a \sin z = (a + h_m) \sin i_0$$

$$\sin i_{\text{sat.}} = \frac{a}{a + h_{\text{sat.}}} \sin z$$

$$\varphi_1 = z - i_0, \quad \varphi_2 = i_0 - i_{\text{sat.}},$$

$$\varphi = \varphi_1 + \varphi_2 = z - i_{\text{sat.}}$$

and $\sin i_0 \leqslant \mu_m \rho_m$

corresponds to the minimum of the $\mu\rho$-curve. In accordance with the calculated values the received signal disappeared usually sooner on 20 Mc./s. than on 40 Mc./s., and only in cases when the signal was coming from countries where for 20 Mc./s. $f \doteq f^c$ was long-distance propagation of the signal around the Earth from the magnetic equator observed.

Summarizing, the rectilinear part of a ray path becomes rotated about the centre of curvature of the ionized layer through which it has penetrated by the angle of refraction R. This deviation R depends only upon i_0, f^c/f and the content of free electrons present in the whole layer, but it is independent of their distribution.

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Free Acid in British Soils

Under the humid climate of northern and western Britain organic materials often accumulate as *mor*[1] humus layers on well-drained woodland soils or as bog peats in wetter locations. Both types of humus are characteristically very acid, and this communication examines the possibility that sulphuric acid is mainly responsible for their low *p*H values.

To study this question in the wetter habitats, water samples were collected from pools on seven areas of bog, listed in order of increasing hydrogen ion concentration in their waters: Cooran Lane, Galloway; Druimbasbie and Strathy, Sutherland; Rannoch Moor; Tregaron, Cardiganshire; Dergoals and Kilkahockadale, Galloway; Moor House, Cumberland; Coom Rigg, Northumberland. All exhibit a good cover of *Sphagnum* moss, a sign that the peats are very wet and in a more or less natural condition. Moreover, they are so deep and extensive that the bog surfaces probably depend for their ion supply almost wholly upon the atmosphere.

Hydrogen ion concentration in the seven areas ranges from 0·03 to 0·13 m.equiv./l., averaging 0·066 m.equiv./l.; while sulphate ranges from 0·06 to 0·24 m.equiv./l., and averages 0·133 m.equiv./l. The coefficient of correlation (r) between free hydrogen ions and sulphate is 0·964, a highly significant value which may be increased by taking into account the appreciable amount of sulphate reaching the bogs in blown sea spray. This fraction may be estimated by assuming all chlorides in these waters to be derived from sea spray[2,3], and dividing the chloride values by 9·7—the ratio of chloride to sulphate in sea water. On subtracting the sea spray contribution from total sulphate, the correlation coefficient between hydrogen ions and the remaining sulphate becomes 0·985. Such a high coefficient strongly suggests that the low *p*H values of these bog waters are indeed due to sulphuric acid. A similar correlation has been observed for individual pools within the Moor House bog[4]. The regression of hydrogen ions upon corrected sulphate in the seven bog areas follows the formula $y = 0{\cdot}556x + 0{\cdot}006$.

The highest acidities are recorded from bogs near industrial areas, while the lowest come from sites remote from industry. Since fuel combustion produces large amounts of sulphur dioxide, which oxidizes to sulphuric acid, bog acidities are directly increased by industrial development nearby. Ringinglow Bog outside Sheffield provides an extreme example, with water analyses from this bog—now in a far from natural state—yielding hydrogen ion and sulphate concentrations of 0·57 and 0·96 m.equiv./l. respectively. In this connexion also, the influence of air pollution on rain acidity is clearly evident in the English Lake District, where the *p*H of precipitation averages less than 4·5 and may occasionally[2,3] go below 4·0.

It may be noted that in these bog waters hydrogen ions are only equivalent to 61 per cent of sulphate (exclusive of that from sea spray). In the Lake District rain the proportion is rather similar.

The free acid in *mor* humus layers was investigated by expressing the soil solution, with the aid of a hydraulic press, from sixteen samples collected in Lake District oakwoods on Silurian substrata. These *mors* overlie heavily leached mineral soils transitional between brown earths and podzols, and exhibiting strong profile development[1].

Hydrogen ion concentration in the *mor* waters ranges from 0·02 to 0·36 m.equiv./l., averaging 0·109 m.equiv./l.; while sulphate ranges from 0·26 to 1·01 m.equiv./l. and averages 0·508 m.equiv./l. The correlation between free hydrogen ions and sulphate (after subtraction of sulphate from sea spray) is again highly significant, with $r = 0{\cdot}872$. Once more, sulphuric acid seems likely to be the main factor responsible for low soil *p*H values, and must greatly enhance leaching. The regression of hydrogen ions upon corrected sulphate follows the formula $y = 0{\cdot}307x - 0{\cdot}033$.

The association between hydrogen ions and sulphate is stronger for the bog waters than for the *mor* soil solutions ($r = 0{\cdot}985$ as against 0·872). Moreover, the proportion of sulphate balanced by hydrogen ions is much greater in the bog waters than in the *mor* solutions (61 as against 24 per cent). It seems likely that an appreciable part of the *mor* acid is neutralized by bases from mineral soil particles embedded in the humus, in which case a lower correlation between hydrogen ions and sulphate is not surprising. It may also be remarked that the average corrected sulphate level in the *mors* (0·46 m.equiv./l.) is considerably above the highest bog value (0·24 m.equiv./l.), owing probably to concentration of the interstitial water in these well-drained soils by evaporation.

As in the case of the bog waters, air pollution can account for much of the free acid in Lake District *mors*[5]. However, even in areas without much industry, sulphuric acid will probably be produced from decomposing organic sulphur compounds[6]. Support for this view may be found in the inter-correlations between free hydrogen ions, sulphate and dissolved organic carbon in waters of Nova Scotian lakes, draining acid peaty soils on substrata low in lime[6].

In conclusion, it must be pointed out that the *p*H values of both bog waters and *mor* soil solutions are a good deal higher than those obtained by direct insertion of a durable glass electrode into fresh soil. For example, at Moor House the *p*H range of 3·7–4·1 for six surface pools may be compared with a range of 3·3–3·9 for eight fresh peats from the same area; while the *p*H range of ten Lake District *mor* solutions, 3·8–4·6, may be compared with a range of 3·2–3·5 for the fresh soil. The much lower *p*H values of the fresh soils are presumably due to a 'suspension effect' on the glass electrode by hydrogen ions adsorbed on soil colloids. Exchangeable hydrogen ions are abundant in both woodland *mors* and bog peats[1,7], and must be, like the sulphuric acid free in solution, of great importance for soil development.

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Influence of Water-Content of Sand on Rate of Uptake of Rubidium-86

The relationship between nutrient absorption and the moisture content of the soil has been the object of numerous investigations. Complications arise, however, if an attempt is made to disentangle the separate processes involved. The growth of the plant itself is strongly influenced by the moisture content of the soil and the ionic equilibria between

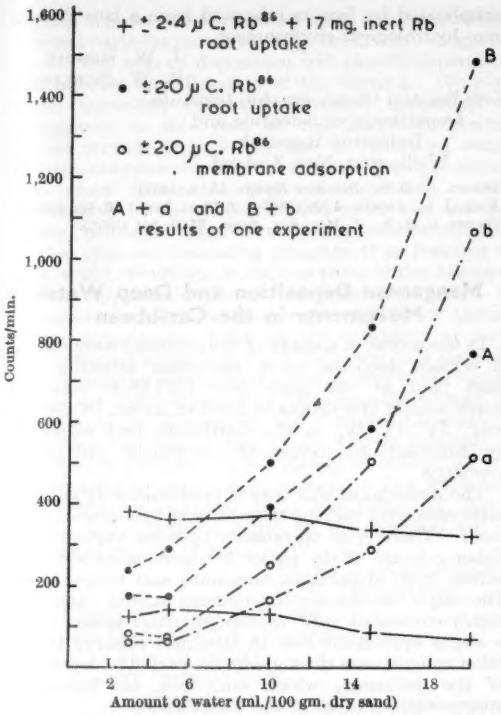

Fig. 1. Uptake of rubidium-86 by excised roots of *Vicia faba* (+ and ●); and by a cation resin membrane, 'Permaplex *C*-10' (○) from 100 gm. dry sand containing a varying amount of water (3–20 ml.)

the adsorbed ions and those in solution undergo a change. Another difficulty encountered is the fluctuation in moisture content of the soil as brought about by transpiration and watering, so that the conditions are not constant during the experiment.

The problem has recently been investigated by Dean and Gledhill[1] and by Danielson and Russell[2], who used techniques to eliminate a number of complications. Their results, however, are contradictory in some respects.

Dean and Gledhill[1] used excised rootmats of young rye seedlings that were pressed upon sand containing a fixed amount of labelled phosphate. One of their findings is that uptake can decrease with an increase of moisture content of the sand, although the reverse may also occur.

Danielson and Russell[2] made use of very young corn seedlings completely buried in the soil. They find that the ion uptake decreased rapidly with initial increases in soil moisture tension, and levelled out at higher tensions to give a curve nearly logarithmic in nature.

An attempt was made to extend our knowledge on the influence of the amount of moisture on the rate of uptake by means of a technique which eliminates complications to a great extent.

The experiments were performed with excised young root pieces of the broad bean (*Vicia faba*), which were taken from the primary laterals of plants cultivated in tap-water. A batch of twenty-five root pieces was buried in 100 gm. of washed sand to which ±2 μc. rubidium-86 was added and a varying amount of water. In part of the experiments a varying amount of inert rubidium chloride was added besides the tracer amount. Experiments lasted about twenty-four hours and were mostly conducted at room temperature.

The results demonstrate that if only a minute amount of rubidium is present in the sand, the uptake greatly increases as the amount of water rises from 2–20 ml. If, however, a larger amount of inert rubidium is added the reverse trend is found and uptake decreases somewhat with increasing moisture content (Fig. 1).

The following explanation seems justified, and is in agreement with experience gained in work with other ions.

As long as the sand contains only a very small amount of rubidium (not exceeding ±4 mgm./100 gm. of sand) the layer in direct contact with the root cannot furnish enough substance to meet the demands of the root. So the rate of uptake will be dependent on the number of ions able to diffuse towards the root from more distant layers. As the moisture content of the sand rises, this diffusion is enhanced, as has been shown by Klute and Letey[3], and uptake increases. The purely physical nature of this response can be demonstrated by the fact that a cation exchange membrane reacts in exactly the same way (Fig. 1).

If, however, the amount of rubidium in the sand is higher, the moist layer surrounding the root will contain more substance than the root can absorb during the experiment. As the sand can be considered as a practically inert medium, the concentration of the rubidium in solution will vary inversely with the amount of water added. Uptake is now governed by the concentration of rubidium in solution in the pore space. So the rate of uptake diminishes somewhat with an increase in the amount of water added.

Thus the relation between moisture content of the medium and rate of uptake depends on the amount of soluble substance. At low concentrations of rubidium the rate of uptake is enhanced by increased moisture content and at higher concentrations the rate of uptake is somewhat lowered.

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Age Determinations of Southern Ocean Waters

A model of Southern Ocean circulation has been provided by Deacon[1] based on that for the South Atlantic and supported by detailed observations made during the cruises of R.R.S. *Discovery II*. On this model, cold dense water forming in the Weddell Sea sinks to the ocean floor to form Antarctic bottom water which exhibits northward and eastward components of motion.

In December 1956 and January 1957 we obtained twenty-gallon samples of bottom water at each of the two stations in the Southern Ocean south of New Zealand. Sampling was carried out from

H.M.N.Z.S. *Pukaki* in the course of an investigation by the New Zealand Oceanographic Institute of the Antarctic convergence and the hydrology of the Ross Sea sector of the Southern Ocean.

The stations were located as follows: (1) Lat. 64° 54′ S., long. 178° 10′ E., 150 miles north of Scott Island (N.Z. O.I. Station B27, 28.12.56). Depth to bottom 3,000 m., depth of sample 2,643 m. (2) Lat. 53° 38′ S., long. 169° 52′ E., 100 miles south-east of Campbell Island. (N.Z. O.I. Station B32, 1.1.57.) Depth to bottom 800 m., depth of sample 765 m.

The apparent carbon-14 ages of these samples were determined by Mr. T. A. Rafter and Mr. G. J. Fergusson in the Nuclear Sciences Division, N.Z. Department of Scientific and Industrial Research: the ages were 2,540 ± 100 years and 1,900 ± 100 years respectively for samples 1 and 2.

The southern station (B27) is located on the north-facing slope leading from the Pacific Antarctic Ridge into the Pacific Antarctic Basin. The station is 500 miles from the nearest Antarctic coast and a somewhat lesser distance north of the average northern limit of Antarctic land. The northern station (B32) is over the Campbell Plateau, south of New Zealand. Here the general depth is 400 fathoms and the Plateau rises steeply from depths greater than 2,000 fathoms to the south and west.

At Station 2 and adjacent to Station 1, temperature–salinity–oxygen profiles were sampled, to bottom at Station 2 and to 2,000 m. near Station 1, the deepest water sampled in the latter case being in the 'warm deep' layer[1]. The carbon-14 sample from Station 1 has come from the boundary zone between Antarctic bottom water and the southward moving 'warm deep' current. Consideration of the hydrological observations obtained at the same time as these samples is being prepared for publication.

Apparent ages of deep Atlantic water have been reported by Kulp[2], the maximum age being 1,950 ± 200 years for a sample from 4,663 m. in the north-west Atlantic. Cooper[3] has pointed out a number of factors, the re-cycling of 'old' water, the time required to achieve equilibrium with the atmosphere and physio-chemical 'ageing' with increase in temperature, which affect direct application of apparent carbon-14 ages to determinations of rates and nature of oceanic circulation systems.

If the generalized model of Southern Ocean circulation be accepted, then, whatever the true age of the water mass from time of formation, the total time which a significant proportion of the water mass sampled has been shielded from the atmosphere could be very great: in high southern latitudes northward-moving deep water will have an apparent age principally determined by the apparent age at formation and the time since sinking.

The Campbell Plateau sample has been obtained from an area in which upwelling induced by the submarine topography could operate to give the high apparent age.

These initial observations are now being continued by the N.Z. Oceanographic Institute over these and more northerly latitudes. The present isolated observations at least suggest that: (1) the value of the latitudinal component of movement of bottom water is low; (2) the total turnover time of ocean circulation systems is of the order of thousands of years; (3) the present oceanic circulation may be found to be complicated by factors inherited from a late Pleistocene hydrological environment.

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Manganese Deposition and Deep Water Movements in the Caribbean

In the course of a study of the chemical composition of certain deep-sea cores, particular attention has been paid to one such core (*A* 179–4) collected south-west of Hispaniola in 2,965 m. at lat. 16° 36′ N., long. 74° 48′ W. in the Caribbean and subjected by Emiliani[1] to oxygen-18 : oxygen-16 palæothermometry.

The material of this core is predominantly calcium carbonate with varying quantities of lithogenous sediment. There is no correlation between variations in either calcium or the major lithogenous constituents (silica, iron, aluminium, titanium) and temperature. The major lithogenous constituents exhibit variations highly correlated *inter se*, though there seems to be a slight systematic rise in titanium relative to the other constituents throughout the period of deposition of the sediment, which embraces, on Emiliani's interpretation, most of the Pleistocene.

The manganese content, however, is entirely unrelated to the lithogenous group of constituents or to calcium. Inspection of the graph (Fig. 1) indicates that manganese is inversely, if somewhat irregularly, related to surface temperature. The correlation coefficient of manganese on temperature, namely, −0·511, is, in fact, highly significant (with 35 pairs of observations, $P \simeq 0{\cdot}001$).

Since manganese is the only abundant constituent likely to be sedimented by purely chemical process in the Atlantic Ocean or adjacent seas, its independent behaviour is not surprising; but the nature of its distribution raises the question as to why it should tend to precipitate at this station more rapidly during glacial than during interglacial periods.

We believe that the best explanation is to be found in Goldberg's[2] hypothesis that colloidal manganese dioxide is deposited electrophoretically in

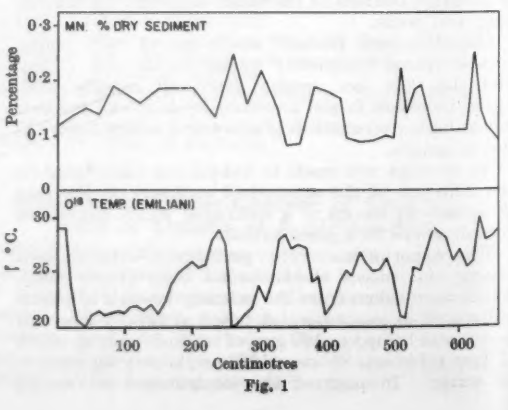

Fig. 1

regions of potential gradient set up as water containing charged particles moves through the Earth's magnetic field. The rate of deposition will clearly depend on the velocity and direction of the current. We consider, therefore, that the enhanced deposition of manganese in this part of the Caribbean during glacial periods is probably due to enhanced water movements related somewhat irregularly to glaciation. The most reasonable type of movement would presumably be the spilling of cold water over the rim of the Caribbean basin. Non-steady state movements of this type are becoming recognized[3] as features of deep water circulation in various parts of the Atlantic. If our hypothesis proves reasonable, variation in manganese content in deep water sediments should throw considerable light on the incidence of such movements throughout the Pleistocene and possibly during more remote periods of the history of the ocean.

We are indebted to Prof. Maurice Ewing and to Dr. David B. Ericson of the Lamont Laboratory, Columbia University, and to Dr. Cesare Emiliani of the Marine Laboratory, University of Miami, for the opportunity to study this material. The work was supported by contract from the Office of Naval Research. A detailed report on the analyses will be published by one of us (P. J. W.) later.

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Sept. 30.

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Grain Boundaries and Electroluminescence in Gallium Phosphide

SOME interesting properties of gallium phosphide have been studied in polycrystalline specimens kindly provided by H. Welker, of Seimens Schuckertwerke, Erlangen. Etching of the surface has revealed grain boundaries, and annealing twins. Etch pits have also been observed along slip lines.

Electroluminescence has been reported previously[1], but that observed here shows unusual features, in that the light sources form a pattern of narrow lines and are identifiable with grain boundaries. Most sources are found in the surface, though sheets of light have been observed, joining more intense sources in opposite faces. Not all boundaries luminesce, and on reversal of the current the light pattern changes markedly. Voltage probing shows that a large and constant proportion of the total applied voltage is developed across the luminescent boundary. Electroluminescence is also observed at a cathode point contact to the *p*-type gallium phosphide, indicating that minority carrier injection and radiative recombination occurs. It is proposed that this is the mechanism responsible for the grain boundary luminescence, and that impurity segregation at the boundary creates an *n*-layer between the *p*-type grains. This forms a *p–n–p* junction, or two *p–n* junctions 'back-to-back', and minority carrier injection and consequent radiative recombination occurs at whichever is the forward-biased junction. A junction of this sort in the grain boundary would account for the observed voltage distribution, and the results of current-voltage studies are in agreement with the theories of Shockley and Prim[2] and Dacey[3] for *p–n–p* structures.

The observation of etch pits along slip lines indicates the possibility that these pits are formed at the points of emergence of dislocations, which would be of considerable interest. Further, if impurities at grain boundaries are responsible for electroluminescence, this phenomenon may prove a useful tool by which to study impurity atmospheres during boundary migration.

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Reaction of Carbon Monoxide with Graphitic Carbon at 450° C.

PUBLISHED investigations of researches on the reaction of carbon monoxide with carbonaceous solids have been concerned with the Boudouard reaction, $2CO \rightleftarrows C + CO_2$. Many measurements have been reported above 500° C. in which range the rate of reaction is appreciable and the resultant partial pressure of carbon dioxide is measurable. Below 500° C. the observed partial pressure of carbon dioxide is so low that it cannot be differentiated experimentally from that normally expected on outgassing such materials, although the equilibrium values for the carbon dioxide are higher than those above 500° C.

Experimental conditions have now been discovered whereby an appreciable reaction occurs between carbon monoxide and some graphites at 450° C. However, carbon dioxide is not formed. The sample was contained in a 'Vycor' tube through which purified carbon monoxide was circulated. Traces of water vapour were continuously removed by liquid nitrogen traps on both sides of the sample tube. When necessary each sample was previously treated with hydrochloric and hydrofluoric acids to assure the absence of metallic impurities as evidenced by spectrochemical analyses. It was then heated for 20–40 hr. with evacuation at either 450° or 700° C. and then cooled in the latter case to 450° C. before the introduction of carbon monoxide. A definite chemisorption of the carbon monoxide was observed. A more significant result was the formation of a carbon deposit downstream at locations well beyond the bed of graphite. Mass-spectroscopic analyses proved the almost complete absence of gases other than carbon monoxide even after the liquid nitrogen was removed. A chemical analysis of the deposit demonstrated it to consist of carbon.

The following mechanism could account for these observations. The first step is the chemisorption of a carbon monoxide molecule. A second carbon monoxide molecule is then chemisorbed to the chemisorption complex, which then reacts to form gaseous carbon suboxide, C_3O_2. This serves to transport the carbon atoms of the graphite through

and out of the bed of sample. Carbon suboxide is unstable at the temperature of the reaction and decomposes in one or more steps to deposit carbon and liberate carbon monoxide.

The first implication of these results is that at a temperature as low as 450° C., small amounts of carbon monoxide can cause migration of carbon atoms and, thus, in a sufficiently long time, could re-form an appreciable fraction of the graphite into a possible new crystalline or amorphous form. Thus far, appreciable reaction has been observed only with graphites which have been irradiated in nuclear reactors, while unirradiated graphite, charcoal, etc., showed only very small traces of carbon transport or none at all. Thus, it is possible that the added energy in the irradiated graphite, and the accompanying structural changes, is responsible in some way for this effect. Further work is needed to prove that only irradiated graphite can produce this transport.

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An Electronic Mechanism of Addition Reactions

It has now become abundantly clear that in ethylene ($CH_2{=}CH_2$) one of the two bonds is of the normal covalent type (σ-bond), while the other belongs to a distinct and separate class (π-bond). Thermochemical studies have further revealed that the bond-strength of a C=C double bond is appreciably less than twice the value for a C—C single bond, showing that the π-bond is not as strong as the σ-bond. Thus it was quite natural to assume that addition reactions occur by the direct rupture of the weaker π-bond. However, it has been found that addition proceeds generally in the *trans* sense, which is exactly contrary to expectation. The reactivity towards addition reactions also decreases unexpectedly with increase in the number of π-bonds (except in conjugation). Acetylene ($CH{\equiv}CH$) with two π-bonds is less reactive than ethylene[1]. The first stage addition to one of the cumulated double bonds in allene ($CH_2{=}C{=}CH_2$), which is expected to be very much strained, is also much slower than the second stage addition to its remaining simple double bond[2]. It is remarkable that higher cumulenes ($>C{=}C{=}C{=}C{=}C{=}C<$) are quite stable[3].

It is thus generally realized that the π-bond itself is not the seat of any weakness in the molecule[4]. It may be that the σ-electrons are in some way connected with this subtle and devious attack on the multiple bonds. It has been found that electrophilic groups retard addition reactions (as in HOOC—CH=CH—COOH), while electron repelling groups accelerate them (as in CH_3—CH=CH_2)[4]. These groups are attached to the carbon atoms of the double bond through σ-bonds. As such, they can affect the reactivity only by depleting or by supplementing the σ-electrons of these carbon atoms. This argument is further supported by the fact that the retarding effect of the electrophilic groups on the reactivity of acetylene derivatives is very small (as in HOOC—C≡C—COOH)[5], because it is difficult to withdraw σ-electrons from a triple bond which itself is strongly electrophilic. On the basis of all these considerations it can be postulated that the initial attack in addition

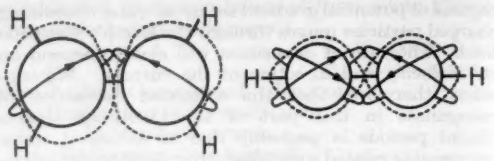

Fig. 1. Electronic structures of ethylene and acetylene. The broken line shows the distorted σ-electron density

reactions occurs on the σ-electrons and the reactivity of the unsaturated molecule depends upon the σ-electron density of the carbon atoms. This concept of addition mechanism through σ-electrons is also in agreement with the fact that frequently substitution and addition occur side by side. At high temperatures substitution increases at the cost of addition. Furthermore, the electrophilic groups also retard substitution in benzene. They de-activate mainly the *ortho* and *para* positions and thus become meta-directing.

It now remains to find the cause of enhanced reactivity of the σ-electrons in unsaturated molecules. It appears that the π-electrons somehow cause this activation of σ-electrons. As the quantum-mechanical approach has not yet succeeded in solving this problem, it may be worth while to develop a tentative speculative explanation based on simple physical concepts. It is generally agreed that the π-electrons can be regarded, from many points of view, as forming a separate shell 'outside' the other electrons[6]. I have gone a step farther in postulating that the planes of the π-electron orbits remain fixed[7]. They couple at an angle which causes the restriction on the free rotation of their orbital planes. Probably the high electron density between the two carbon atoms due to the σ-bond does not permit the exchange of two more (π) electrons through the same region (Fig. 1).

The spherical symmetry of the σ-electron density of the carbon atom becomes distorted as a result of the fixation of π-electron density around it. On the particle concept of the electron, these distortions of σ-electron orbits would be unsteady and non-uniform. Some of the σ-electrons may become deviated (due to repulsion from the fixed π-electron orbit) much more than others. These abnormally deviated σ-electrons may bond an extra atom temporarily. This sudden electronic disturbance would break the π-bond, and one of the π-electrons set free is utilized in forming a stable covalent bond with the addendum. The π-electron on the other carbon atom remains free for a while and becomes saturated through a distinct second phase of addition. This interval provides scope for steric rearrangements giving *trans* products. In the fast reactions the *cis* products predominate. In some of the molecules one of the atoms already present may be knocked out in favour of the new entrant, thus causing substitution. In benzene, substitution is relatively easier than addition as the π-bond in it is stronger than in simple multiple bonds[8].

The distortions of the σ-electron orbits would be proportional to the σ-electron density on the carbon atom. This explains the lower reactivity of acetylene (two σ-electrons per carbon atom), and the retarding effect of electrophilic groups. The central atoms in cumulenes, containing only two σ-electrons each, act as electrophilic groups on the reactivity of the end CH_3-groups[9]. The activating effect of such groups as CH_3 does not appear to be due to electron donation, as they increase the reactivity of acetylenic com-

pounds to only a very small extent. They appear to have an obstruction effect which increases the abnormal distortions of σ-electron orbits in other directions.

Other aspects of unsaturated molecules, such as bond-lengths, Pascal's constitutive correction factor λ for the multiple bonds, etc., have been discussed in terms of these concepts elsewhere[7,8].

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Infra-Red Absorption of OH Bonds in Micas

IN favourable cases, infra-red absorption spectra afford a valuable adjunct to diffraction methods in crystal structure analyses. The structures of the micas have been familiar for many years, but have never included any specification for the site of the proton in the constitutional hydroxyls.

In the biotite micas (such as phlogopite, $K_2(Si_6Al_2)Mg_6O_{20}(OH)_4$), if one assumes tetrahedral environment for oxygen, three of the tetrahedral hybrid orbitals are involved with magnesium neighbours, the bond to the proton must have its axis normal to the cleavage, and steric factors preclude that the proton has a secondary association with any other oxygen. In muscovite,

$$K_2(Si_6Al_2)Al_4O_{20}(OH)_4,$$

only two orbitals are involved with aluminium neighbours, and the O—H bond axis could be normal to the cleavage as above, or could be directed toward the unoccupied cation site, thus lying no more than 15–20° inclined to the cleavage, and probably favourably disposed for secondary association with one or both near oxygen neighbours as an O—H . . . O bond.

The efficiency of absorption in the frequencies associated with the O—H bond is a function of the angle between the bond axis and the plane of the electric vector of the light. For normal incidence on a phlogopite cleavage flake, there is no resultant along the OH bond axis and no absorption in the region of the OH stretching frequency. With increasingly inclined incidence, absorption increases regularly with the increasing resultant of the plane of the electric vector on the bond axis. The observed frequency for unmodified OH stretching is 3,710 ± 20 cm.$^{-1}$. When muscovite is examined similarly, strong absorption is observed for normal incidence at 3,620 ± 20 cm.$^{-1}$, and the absorption is not markedly sensitive to moderate tilting of the flake. It is concluded that the O—H bond axis must have one or more of the orientations near the plane of the cleavage flake for the dioctahedral composition, and that the lesser frequency may be evidence of some hydrogen bonding.

A third case illustrates the precision of observations. Lepidolites present frequent instances in which analyses suggest that a trioctahedral lithium-bearing biotite and a typical muscovite are intimately parallel grown. Spectra at normal incidence and at increasingly inclined incidence to the lepidolite illustrated show absorption at the muscovite frequency with little sensitivity to orientation and absorption at the phlogopite frequency with sensitivity to orientation as in phlogopite.

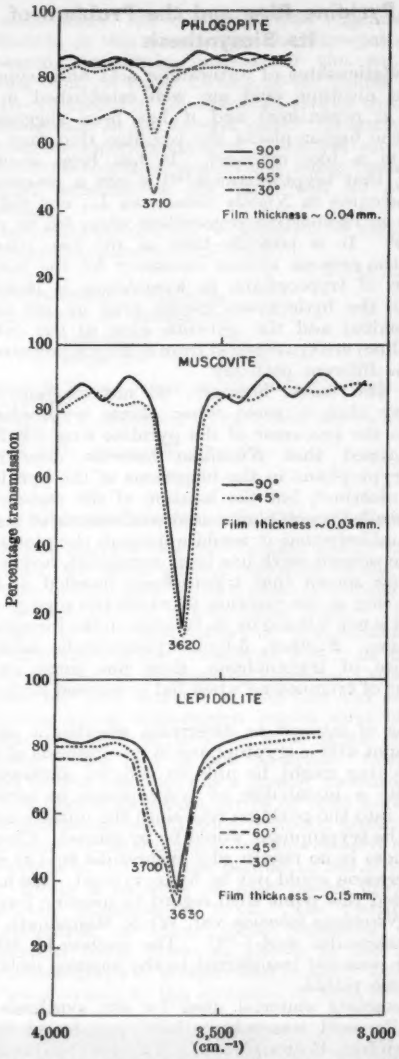

Fig. 1. Infra-red spectra of phlogopite, muscovite and lepidolite for cleavage flakes oriented at different angles to the incident beam

The spectra in Fig. 1 were recorded with a Perkin–Elmer Model 21 double-beam spectrometer with a sodium chloride prism.

We have recently learned that a more elaborate analysis, in substantial agreement with our present communication, was conducted during the War by Dr. G. B. B. M. Sutherland for the U.S. Army Signal Corps, but not published.

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The Pyridine Ring and the Problem of its Biosynthesis

The relationships of anthranilic acid and tryptophane to nicotinic acid are well established in a number of organisms[1] and it has been suggested that in the higher plants the pyridine ring may be formed in a like manner[2]. It has been shown, however, that tryptophane-3-^{14}C is not a precursor of damascenine in *Nigella damascena* L., nor did it give rise to radioactive trigonelline when fed to pea seedlings[3]. It is possible that in the two plants studied the enzyme system necessary for the initial oxidation of tryptophane to kynurenine is lacking and that the hydroxyanthranilic acid in one case (damascenine) and the pyridine ring in the other (trigonelline) are synthesized from different precursors and by a different pathway.

These two cases, however, do not exclude the possibility that in some other plants tryptophane might be the precursor of the pyridine ring. It has been claimed that *Nicotiana tabacum* does not utilize tryptophane in the biogenesis of the pyridine ring of nicotine[4], but the location of the carbon-14 in the labelled tryptophane used was such as to make it very unlikely that it would appear in the nicotine. Since the present work has been completed, however, Leete[5] has shown that tryptophane labelled in the benzene ring at the position to which the nitrogen is attached is not utilized by *N. tabacum* in the formation of nicotine. Further, 3-hydroxyanthranilic acid, a metabolite of tryptophane, does not serve as a precursor of trigonelline when fed to excised soybean leaves[6].

It was of interest to determine whether a plant that cannot utilize tryptophane in its synthesis of the pyridine ring might be able to convert anthranilic acid (also a metabolite of tryptophane in certain moulds) into the pyridine ring since the initial oxidation of the tryptophane would be by-passed. Chemically, there is no reason why anthranilic acid as well as kynurenine could not be hydroxylated. We have now tested this point with regard to nicotine formation in *Nicotiana tabacum* var. White Mammouth fed with anthranilic acid-1-^{14}C. The carbon-14 label, however, was not transferred to the nicotine isolated from these plants.

The starting material used for the synthesis of anthranilic acid was toluene-1-^{14}C (purchased from Tracerlab Inc., Boston, Mass.). Nitration followed by oxidation of the resulting nitrotoluenes with permanganate afforded a mixture of nitrobenzoic acids from which most of the *p*-isomer was separated as its sparingly soluble copper salt[7]. Catalytic reduction of the recovered crude *o*-nitrobenzoic acid yielded anthranilic acid which was precipitated from neutral solution as its insoluble cobalt complex[8]. Treatment of the complex with hydrogen sulphide liberated very pure anthranilic acid which was isolated with ether, sublimed and crystallized from water from which it separated as needles, m.p. 144–145°.

The tobacco plants were grown from seed in soil for two months and then transferred to a nutrient solution prepared as described by Leete[9], but modified by substituting ferric tartrate as the source of iron. The nutrient solution was aerated continually and changed weekly. It was necessary to add further quantities of ferric tartrate (4·0 mgm. per l.) twice a week to suppress signs of iron deficiency in the plants. After three weeks, five plants were each suspended in a quantity of the nutrient solution and anthranilic acid-1-^{14}C (300 mgm.) of specific activity $1{\cdot}1 \times 10^7$ disint. per min. per m.mol. was divided equally between the five solutions. After 10 days of contact the nutrient solutions (total activity $1{\cdot}65 \times 10^8$ disint. per min.) were discarded and replaced by fresh solution (without labelled material). Eighteen days after feeding the anthranilic acid the plants were harvested, extracted with dilute hydrochloric acid and the nicotine separated from this extract (total activity $4{\cdot}8 \times 10^6$ disint. per min.) by distillation from alkaline solution[10] followed by precipitation as the dipicrate. Nicotine dipicrate crystallized from 30 per cent dimethylformamide as yellow needles, m.p. 223–224°, unaltered by mixture with an authentic sample. A quantity of the dipicrate was converted to the diperchlorate separating from the ethanol as needles, m.p. 207–208° either alone or in admixture with an authentic sample. Paper chromatography[11] showed nicotine to be the only pyridine base detectable in the crude plant extract. The nicotine salts showed no significant radioactivity.

From Leete's work[9] there is no doubt that the tobacco plant synthesizes nicotine at the stage of growth at which the present experiments were performed. Hence anthranilic acid does not function as a precursor of the pyridine ring of nicotine. Surprisingly, lysine does not give rise to the pyridine ring of nicotine either[9], nor is it the precursor of the α-pyridone ring of ricinine (Reist, E. J., and Marion, L., unpublished results). A body of evidence is, therefore, accumulating according to which it seems improbable that in the higher plants the pyridine ring would have its source in either tryptophane or lysine, which appeared to be the two most plausible precursors. It is true that according to Dawson *et al.*[12] the preformed pyridine ring (nicotinic acid) can be utilized by the plant in the synthesis of nicotine; but this does not seem to have much bearing on the initial formation of the pyridine structure. It now appears likely that the pyridine ring might be built directly from smaller units arising from alanine and glycine, or possibly from non-nitrogenous precursors, and ammonia. In micro-organisms where tryptophane functions as the precursor of nicotinic acid, the pyridine ring must arise by ring closure of an oxidative intermediate compound, which in the higher plants might be built up at a much faster rate from smaller units than it can be formed from the metabolites of tryptophane. The fact that nicotinic acid takes part in the biogenesis of nicotine[12], whereas tryptophane does not[5], lends support to this possibility, which is being investigated.

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A Quantitative X-Ray Study of Alpha-Beta Transformation in Keratin

THE first X-ray diffraction studies of the α–β transformation in keratin were made by Herzog and Jancke[1] and Astbury and Street[2]. Since then it has occupied a pivotal position in all attempts to determine the molecular structure of proteins. Recently, Bendit[3] has reported the variation of the peak intensity of the 5·1 A., 4·6 A. and 9·8 A. reflexions against percentage extension for Lincoln wool and concluded therefrom that Astbury's hypothesis of a molecular transformation based on a 1 : 1 correspondence of the intensity variation of the first two reflexions is not tenable. However, no quantitative X-ray study of the degree of order introduced with extension has been yet reported.

The outstanding reflexions in the alpha-photograph of human hair are the meridional strong arc of spacing 5·15 A., made up of (020) flanked on either side by (120), and the composite equatorial reflexions (001), (101), (300) and (201), spread over 3 A. and having a mean spacing of 9·8 A. The (100) reflexion, because of its proximity to the centre and poor definition, does not lend itself to an easy evaluation and is therefore omitted. During the course of transformation from alpha to beta, which sets in at about 30 per cent extension, the meridional arc begins to close up while there appears on the equator a new spot of 4·65 A., and the overall definition of the photograph also improves. However, the dark arc never completely disappears. If we denote the total intensity of the meridional and equatorial spots by I_m and I_e, respectively, then the degree of order, Ω, may be defined by the relation :

$$\Omega = \frac{I_e - I_m}{I_e + I_m} \times 100$$

This expression has the advantage of being independent of all exposure factors.

In order to carry out an experimental determination of this degree in three different varieties, X-ray photographs, using copper K_α radiation, monochromatized by reflexion from a calcite crystal, were taken of bundles of human hair well-combed to ensure parallelism and held taut between two pin-vices one of which was movable and carried a screw-gauge to measure extension. The fibres were always stretched in water at room temperature and supercontracted by stretching first in steam and later allowing them to recover in steam itself. Intensity measurements were made by Moll's recording-type microphotometer and they were reduced to the same scale. The results obtained are shown in Table 1.

These results show that the change is exponential. Initially there is a rapid rise in the degree of order, but from 60–70 per cent extension the change is not very large. The behaviour of golden hair is much nearer to that of black than to that of white. The difference may be due to the presence of air bubbles in white hair. On treatment with cuprammonium hydroxide it was found that the fibre-pattern disappeared completely because of the contraction arising from an extra folding of the chains induced by co-ordination of the absorbed copper with appropriate groups in the keratin chain. A study of this 'reversible super-contraction' produced on washing with dilute sulphuric acid is also being made, and a detailed account of the work will be published elsewhere.

Table 1

Variety	Super-contracted	Un-stretched	Stretched (per cent)			Treated with cuprammonium hydroxide
			40	60	70	
Black	38·13	43·97	51·9	53·19	54·09	0
Golden	37·58	41·8	48·01	50·12	51·12	0
White	34·21	37·03	43·82	45·83	46·60	0

I am indebted to Prof. K. Banerjee for his guidance and encouragement in this work.

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Fibrous Structure in Cheese Curd

IN the manufacture of Cheddar cheese the curd granules fuse under gravity into solid blocks, usually 6–12 in. in thickness. At the same time some spreading or flow of the blocks takes place. This flow appears to be responsible for the characteristic fibrous texture in the 'cheddared' curd. In designing a curd-fusing or cheddaring machine Czulak and Hammond[1] took account of this fact and arranged, following initial compression into a solid block, to submit the curd to pressure in a longer chamber, thereby giving flow in one direction. Curd cheddared in this machine has a greatly increased longitudinal fibrous structure, strips of curd some 20 in. in length being readily torn from the block.

Microscopic examination by fluorescence methods of sections of the curd cut parallel to the direction of flow shows a network of long casein fibrils of a minimum thickness of 0·1μ. The picture at a magnification of about 1,400 resembles that of coagulated blood fibrin as shown in the electron photomicrograph of Wolpers and Ruska[2]. In sections cut transversely to the direction of flow, or in curd

Fig. 1

which has not been submitted to flow, few of these fibrils appear.

The electron micrographs of Imhof and Hostettler[3] show that, following a linear aggregation of casein micelles (each micelle containing about 1,000 casein molecules) at the initial coagulation of the milk by rennet, fusion of the micelles occurs during the later stages of the cheesemaking process. The electron micrographs of Baud, Morard and Pernoux[4] seem to indicate the formation of appendages which afterwards serve to join the micelles during coagulation. The fibril formation which we have observed could be explained by the orientation of the separate casein molecules (axial ratio about 8 : 1) and their more or less end-to-end attachment, or more readily by some uncoiling of the polypeptide chains. The flow of the curd mass could itself contribute to this uncoiling, since proteins may be denatured by mechanical shearing action.

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First and Second Cycle Casein in Milk

The component of the casein complex which, according to Waugh and Von Hippel[1], is responsible for the colloid chemical stability of the casein micelles in milk is *k*-casein. The same authors have also given its preparation, as follows. The casein in skim milk is precipitated by addition of calcium, and by subsequent removal of calcium from the precipitate a solution of the so-called 'first cycle casein' is obtained. This first cycle casein contains β-casein and the α/*k*-complex. Reprecipitating first cycle casein with 0·25 *M* calcium chloride at 37° C. results in the splitting of the α/*k*-complex and hence in the chemical instability of the casein micelles in the colloid. The precipitate was named 'second cycle casein', and it no longer contains the protective *k*-casein in stabilizing quantities. The latter can be isolated from the remaining supernatant of second cycle casein. In its physico-chemical properties, such as electrophoretic mobility, diffusion and ultracentrifugation characteristics, *k*-casein was shown to resemble α-casein closely.

The present communication deals with an electrophoretic study of first and second cycle caseins both with and in the absence of the milk-clotting enzyme rennin.

From an earlier investigation by Nitschmann and Lehmann[2] with acid-precipitated casein it is known that the rennin action electrophoretically is characterized by the splitting of the α-peak into two distinct components, namely, α_1- and α_2-casein, with nearly the same mobilities. We have repeated the Nitschmann/Lehmann experiment both with first and second cycle casein.

Table 1

Exp.	Substrate	Rennet	α_1/α_2 split	α_2 (per cent)	$\mu_{\alpha_1} \times 10^5$ (cm.²/V./sec.)
A	First cycle casein	Heat-inactivated	Occasionally	27	8·98
B	Second cycle casein	Heat-inactivated	Unseparated	13	10·90
C	First cycle casein	Active solution	Very pronounced	29	9·05
D	Second cycle casein	Active solution	Pronounced	14·5	10·70

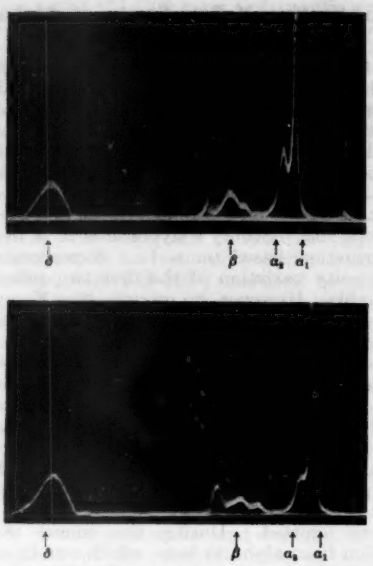

Fig. 1. Ascending electrophoretic patterns of first and second cycle caseins after 4,800 sec. Conditions of experiment: protein concentration, 1·7 per cent; Michaelis buffer *p*H = 7·3, Γ/2 = 0·1; field strength, 9·75 V./cm.; 2° C. Above: first cycle casein, active rennet solution added; below: second cycle casein, active rennet solution added

The caseins were incubated at 35° C. with a solution of commercial rennet powder (1 : 100,000) of the N.V. Chemische Industrie Van Hasselt, Amersfoort, Holland. The rennet concentration was chosen such that 10 mgm. rennet were added per gram of casein. In this way its concentration is too low to be distinguished electrophoretically. For comparison heat-inactivated enzyme was also added to first and second cycle casein. The experiments were repeated several times. A typical set of experiments are summarized in Fig. 1 and Table 1, which show that α_2-casein is much less abundant in second cycle than in first cycle casein. These results suggest that α_2-casein is closely related to the *k*-casein of Waugh and Von Hippel: possibly the two components are actually identical.

Additional support for this conclusion is found in a comparison of the mobilities of the α_1-component in first and second cycle casein (Table 1, column 6). The mobility of the α_1-casein is considerably higher in second ($10{\cdot}80 \pm 0{\cdot}1 \times 10^{-5}$ cm.²/V./sec.) than in first cycle casein ($9{\cdot}02 \pm 0{\cdot}03 \times 10^{-5}$ cm.²/V./sec.). Obviously this mobility increase is due to the decrease in α_2-content in the second cycle and the accompanying decrease in α_1/α_2-interaction.

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Arylsulphate Synthesis and the Arylsulphatases

DURING the course of studies on the synthesis of sulphate esters an opportunity was taken to obtain evidence to support the suggestion[1] that the type II mammalian arylsulphatases (arylsulphatases *A* and *B*)[2] were unlikely to be directly involved in the synthesis of arylsulphates by particle-free mammalian liver preparations. It has already been pointed out[3] that the type I arylsulphatase of mammalian livers (arylsulphatase *C*) cannot be directly involved in this synthetic process since the enzyme is microsomal in origin and highly insoluble. Similar considerations do not apply to the type II enzymes, however, since although they are mainly associated with the so-called 'light mitochondria', appreciable amounts are always present in preparations of the soluble components of the liver cell[4].

The arylsulphate-synthesizing system of mammalian livers is known to involve at least two main steps; the production of an active form of sulphate (3′-phosphoadenosine-5′-phosphosulphate) and the subsequent transfer of the sulphate group of this compound to a phenolic acceptor via the agency of a specific transferase enzyme. Particle-free rat-liver preparations[5] of this synthetic system contained appreciable amounts of the type II arylsulphatases. The average activity of the dialysed preparations was such that 1 ml. liberated 2 μmole nitrocatechol/hr. at 37·5° from 0·005 *M* dipotassium 2-hydroxy-5-nitrophenyl sulphate (nitrocatechol sulphate) in 0·5 *M* acetate buffer, *p*H 5·0 (conditions favouring arylsulphatase *A* activity) and 4 μmole nitrocatechol/hr. from 0·02 *M* nitrocatechol sulphate in 0·5 *M* acetate buffer, *p*H 6·0 (conditions favouring arylsulphatase *B* activity). For various reasons[2] these values can only be regarded as approximations. When fortified[6] with adenosine triphosphate and magnesium and sulphate ions and incubated in the presence of 0·05 *M* phosphate buffer, *p*H 7·0, the dialysed preparations were capable of synthesizing approximately 0·1 μmole *p*-nitrophenyl sulphate, nitrocatechol sulphate or *p*-acetylphenyl sulphate/hr./ml. from the respective parent phenols.

Further purification of the system by ammonium sulphate fractionation according to the directions of Segal[5] concentrated both the synthetic and the arylsulphatase activities. However, no loss in type II arylsulphatase activity occurred when the system synthesizing 3′-phosphoadenosine-5′-phosphosulphate was destroyed by treatment with glycylglycine[6] or when the enzyme system responsible for transfer of sulphate from 3′-phosphoadenosine-5′-phosphosulphate to the phenolic acceptor was inactivated by heat treatment[6]. Purified samples of mammalian arylsulphatases *A* and *B* also showed no loss in activity when subjected to these inactivation procedures. Addition of these purified samples to the arylsulphate-synthesizing system decreased the activity of the system slightly, while addition of the purified soluble type I arylsulphatase of *Alcaligenes metalcaligenes*[7] strongly inhibited the synthetic process. This is not surprising, since the hydrolytic activity of this bacterial enzyme is unaffected by the phosphate and sulphate ions present in the synthesizing incubation mixture whereas the hydrolytic activity of the type II mammalian arylsulphatases is considerably inhibited by these ions.

It seems probable, therefore, that the arylsulphatases cannot be directly concerned in the synthesis of arylsulphates via 3′-phosphoadenosine-5′-phosphosulphate, and these conclusions are supported by the recent observation (Spencer, B., personal communication) that incubation of purified samples of mammalian arylsulphatases *A* and *B* with *p*-nitrophenol in the presence of 3′-phosphoadenosine-5′-phosphosulphate did not effect any sulphate synthesis.

One of us (H. B.) is grateful to the Medical Research Council for a research assistantship.

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Effect of Chymotrypsin on Cæruloplasmin

INTEREST has been shown in the blue, copper-containing, serum oxidase cæruloplasmin, in particular because of its absence from the blood of subjects with hepatolenticular degeneration[1]. The copper of cæruloplasmin is firmly bound, being non-dialysable at neutral *p*H[2]. As part of a study of the mode of linkage of copper to the apo-enzyme, the effect of chymotryptic digestion on cæruloplasmin was investigated.

Cæruloplasmin was prepared from the *G*2 plasma fraction of Kekwick and MacKay[3] using a modification of the method of Kominz[4]. The final blue material had a broad absorption peak with maximum at about 610 mμ. Copper content was determined by a diethyldithio–carbamate method[4] and cæruloplasmin content calculated from Holmberg and Laurell's[2] finding of 0·34 per cent copper in cæruloplasmin. Purity was about 70 per cent. An amount of the material containing 20 mgm. cæruloplasmin was digested with 3 mgm. 'Armour' chymotrypsin in 10 ml. 0·05 *M* *p*H 7·5 sodium phosphate buffer—0·10 *M* sodium chloride at 37° for 22 hr. At intervals during digestion, optical density at 610 mμ was measured and aliquots taken to which tetra-ethyl pyrophosphate was added to inhibit chymotrypsin. Oxidase activity was determined colorimetrically using N,N-dimethyl *p*-phenylene diamine as substrate (see caption to Fig. 1). Non-dialysable copper was also determined on three aliquots. Results are shown in Fig. 1. Enzymic activity and the blue 610-mμ peak decreased during digestion until after 22 hr. they were negligible. (The residual absorption at 610 mμ after 22 hr. was no longer a peak and was part of a spread of the normal protein 280-mμ peak into the visible range. This spread seems characteristic of copper proteins[5]. The 610-mμ peak of cæruloplasmin is destroyed by ascorbic acid[5], but the 610-mμ optical density after 22 hr. digestion was found to be unaffected by ascorbic acid.) Non-dialysable copper also decreased during digestion, but after 22 hr. it was about half that of the original cæruloplasmin.

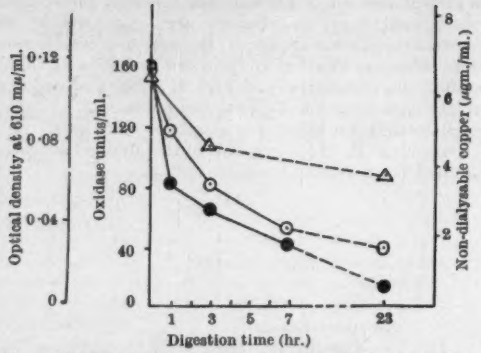

Fig. 1. Effect of chymotryptic digestion on cæruloplasmin oxidase activity, optical density at 610 mμ and non-dialysable copper. ●, Oxidase activity; ⊙, optical density at 610 mμ/ml.; △, non-dialysable copper.

Oxidase activity was determined by adding 2·0 ml. 0·2 *M* *p*H 5·5 sodium acetate–acetic acid buffer to 1·0 ml. cæruloplasmin solution in 0·10 *M* sodium chloride and incubating at 37° for 15 min. with 1·0 ml. fresh aqueous 0·025 per cent *N*,*N*-dimethyl *p*-phenylene diamine dihydrochloride. The oxidase reaction was stopped by 2·0 ml. 0·05 per cent aqueous sodium azide and the red colour measured at 550 mμ on a *SP*600 spectrophotometer. A blank was run simultaneously. A unit of enzymic activity was taken as the activity of an amount of cæruloplasmin which gave under the above conditions an optical density of 0·10/cm. light path. There is a linear relationship between amount of cæruloplasmin and optical density in the density range 0–0·15

Three further cæruloplasmin samples were digested with chymotrypsin. In all cases blue colour disappeared and non-dialysable copper after digestion was about half the original cæruloplasmin copper (Table 1). In digestion 4, after 65 hr. digestion, an aliquot of the non-dialysable material was taken, the original amount of chymotrypsin present doubled and digestion at 37° allowed to proceed for a further 23 hr. Non-dialysable copper after this second period was 99 per cent of that after 65-hr. digestion.

The results suggest that of the eight atoms of copper[3] in the cæruloplasmin molecule, four only are in a region that is attacked by chymotrypsin. During digestion, proteolysis of this part of the cæruloplasmin molecule occurs together with loss of blue colour and enzymic activity. The apparent resistance of the other part of the cæruloplasmin molecule to chymotryptic attack may be quite unrelated to its copper component. However, it is known that the iron- or copper-binding protein conalbumen is resistant to chymotrypsin, but only in the iron- or copper-containing forms[4]. Thus it is possible that half the atoms of copper in cæruloplasmin are bound in such a way that they confer chymotrypsin resistance on a portion of the cæruloplasmin molecule.

It is of interest that other workers[7] have recently shown that in the presence of ascorbic acid, half the copper in cæruloplasmin is exchangeable with copper-64. This also implies an accessibility of one half only of cæruloplasmin copper.

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Table 1. Non-dialysable Copper in Chymotryptic Digests of Cæruloplasmin

Digestion Exp. No.	Cæruloplasmin (mgm.)	Chymotrypsin (mgm.)	Digestion time (hr.)	Per cent copper non-dialysable after digestion
1 (see Fig. 1)	20·1	3	22	56
2	7·0	1	22	52
3	9·0	3	22	49
4	11·8	2	65	55

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Isoleucine and Allo-isoleucine

During our investigations on amino-acid analysis on ion exchange resins using Moore and Stein's method[1], it was seen that in a synthetic mixture of 13 amino-acids (Hoffmann-LaRoche, mostly in the *l*-configuration) the 'methionine' recovery was always too high (120–150 per cent of the theoretical amount) and the '*iso*leucine' recovery always too low (65–70 per cent of the theoretical amount).

On analysing a single sample of '*l-iso*leucine' we found two peaks on the chromatogram, the main one in the usual *iso*leucine position and a smaller one at the methionine position (Fig. 1, *B*). According to Piez[2], who succeeded in separating chromatographically a commercial sample of *dl-iso*leucine into *d-iso*leucine and *d*-allo-*iso*leucine, the 'impurity' is the stereoisomeric allo-*iso*leucine. Piez also found the allo-*iso*leucine coming out of the column at the methionine position.

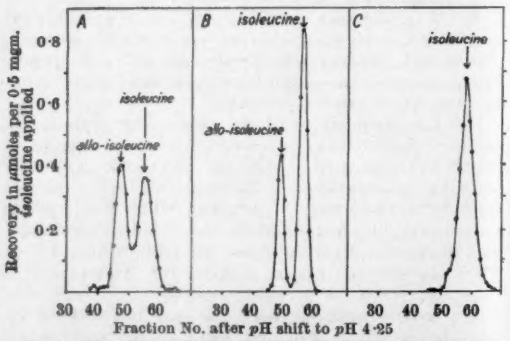
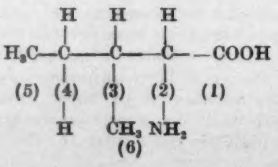


Fig. 1. Chromatograms of samples of: *A*, 0·201 mgm. of *dl-iso*leucine (Nutr. Biochem. Corp.); *B*, 0·312 mgm. of *l*(+) *iso*leucine (Hoffmann–La Roche); *C*, 0·530 mgm. of *l*(+) *iso*leucine (Mann Res. Lab.) applied on 100-cm. ion exchange columns containing 'Dowex 50' (*A* and *C*) or 'Zeokarb 225' (*B*). Elution first with 170–200 ml. citrate buffer at *p*H 3·42 (t = 37·5° C.) and then with citrate buffer at *p*H 4·25 (t = 50·0° C.). 1-ml. fractions were collected

*Iso*leucine has two asymmetric C-atoms (Nos. 2 and 3):



and consequently has 4 stereoisomeric configurations. These are called *l-iso*leucine, *d-iso*leucine (stereoisomeric with the *l*-configuration at carbon atom 2), *l*-allo-*iso*leucine (stereoisomeric with *l-iso*leucine at carbon atom 3) and *d*-allo-*iso*leucine. In this connexion it may be pointed out that an allo-configuration is also possible for hydroxyproline, hydroxylysine and homoserine (erroneously called threonine by Shulgin[3]), which also contain 2 asymmetric carbon atoms. These allo-configurations have been found by Piez[2], Witkop[4], Hamilton[5] and Shulgin[3].

After chromatographic separation on both 'Zeokarb 225' and 'Dowex 50', with the ninhydrin procedure developed by Moore and Stein[6], for the different analysed *iso*leucines we obtained the following results:

Applied	Ion exchange resin	Found Allo-*iso*leucine	Found *Iso*leucine
0·201 mgm. *dl-iso*leucine (Nutr. Bioch. Corp.)	'Dowex 50'	0·103 mgm.	0·108 mgm. (Fig. 1,*A*)
0·505 mgm. *l*(+) *iso*leucine (Hoffm.–la Roche)	'Dowex 50'	0·132 mgm.	0·331 mgm.
0·312 mgm. *l*(+) *iso*leucine (Hoffm.–la Roche)	'Zeokarb 225'	0·095 mgm.	0·201 mgm (Fig. 1,*B*)
0·502 mgm. *l*(+) *iso*leucine (Nutr. Bioch. Corp.)	'Zeokarb 225'	—	0·475 mgm.
0·530 mgm. *l*(+) *iso*leucine* (Mann Res. Lab.)	'Dowex 50'	—	0·516 mgm. (Fig. 1,*C*)
0·546 mgm. *l*(+) *iso*leucine* (Mann Res. Lab.)	'Zeokarb 225'	—	0·504 mgm.

* Offered as 'allo-*iso*leucine free'

It can be seen that two of the four analysed *iso*leucine preparations consist of a mixture of the two stereoisomers *iso*leucine and allo-*iso*leucine. One sample, which contains no allo-*iso*leucine, was offered as 'allo-*iso*leucine free'. So certainly most of the commercial *iso*leucine samples which give no indications about their allo-*iso*leucine content (and probably all of the *dl* samples) will contain this allo-*iso*leucine in considerable amounts.

Though it is known that out of the four stereoisomeric *iso*leucines only *one* (*l-iso*leucine) can be used by the organism[7], the allo-*iso*leucine content of the commercial *iso*leucine is often neglected in human and animal feeding experiments with *iso*leucine.

We also studied the influence of acid hydrolysis, as used in the analysis of proteins[6], on the stereochemic configuration of *l*(+) *iso*leucine.

We found that hydrolysis with 6 *N* hydrochloric acid does not change the configuration of *iso*leucine. This could be demonstrated by boiling a sample of *iso*leucine free from allo-*iso*leucine (Mann Res. Lab.) for 22 hr. in 6 *N* hydrochloric acid followed by chromatography on 'Zeokarb 225'. The results were:

Applied	Found Allo-*iso*leucine	Found Leucine
0·394 mgm. *l*(+) *iso*leucine Mann (Hydr. I)	—	0·371 mgm. (= 94 per cent)
0·134 mgm. *l*(+) *iso*leucine Mann (Hydr. II)	—	0·130 mgm. (= 97 per cent)

There was only one peak, in the *iso*leucine position, and the *iso*leucine recovery was nearly quantitative. No racemization to allo-*iso*leucine took place under these conditions.

In the chromatographic analysis of protein hydrolysates following acid hydrolysis according to Schram[8], the values for *iso*leucine and methionine are not influenced by allo-*iso*leucine formation.

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Enzymic Synthesis of Nitrogen-containing Disaccharides by α-Galactosyl Transfer

Serological and enzymic inhibition tests with simple sugars and oligosaccharides of known structure have in recent years given valuable indications about the sugars which are most important for specificity in the complex mucopolysaccharide materials possessing blood-group activity[1]. Di- and tri-saccharides of known structure which are composed of the sugars present in the blood-group substances are required in order to extend these observations; the enzymic syntheses of two such disaccharides which have not previously been described, α-D-galactosyl-(1→6)-N-acetyl-D-glucosamine (1) and α-D-galactosyl-(1→6)-N-acetyl-D-galactosamine (2), are reported here.

Synthesis of β-linked disaccharides containing amino-sugars was achieved using β-galactosidase preparations from *L. bifidus* var. Penn[2] and *E. coli*[3]. For the present work the α-galactosidase which occurs, with many other glycosidases, in saline extracts of autolysed *Trichomonas foetus* organisms[4] was used as the synthesizing enzyme. Chromatographic examination of the reaction mixtures obtained when melibiose or phenyl-α-galactoside were incubated with *T. foetus* extracts in the presence of large quantities of D-glucose, D-galactose, D-mannose, N-acetyl-D-glucosamine or N-acetyl-D-galactosamine revealed the formation of reducing disaccharides which were absent from the mixture before incubation; these disaccharides had presumably been synthesized by the enzymic transfer of the α-galactosyl residue from melibiose or phenyl α-galactoside to the second sugar present in the reaction mixture. In the digests containing amino-sugars higher oligosaccharides, which gave positive reactions in tests for N-acetyl hexosamines, were detected in addition to the disaccharides, when melibiose was used as a substrate. In view of the possible use in blood-group studies of the disaccharides containing N-acetylglucosamine and N-acetylgalactosamine these two compounds were prepared on a larger scale for isolation and identification. Melibiose (5 gm.) and N-acetylhexosamine (3 gm.) in 50 ml. of 0·1 *M* phosphate buffer *p*H 6·8 were added to 50 ml. of a freshly prepared *T. foetus* extract and incubated for 18 hr. at 37°. The two disaccharides (1) and (2) were separated from their respective reaction mixtures by chromatography on charcoal : 'Celite' (1 : 1) columns; each was finally obtained as an amorphous white powder which gave only one spot when examined chromatographically in three different solvent mixtures. The yields were about 600 mgm. of the compound containing N-acetylglucosamine, disaccharide (1), and about half this amount of disaccharide (2). The high positive rotations ((1)$[\alpha]_D$ + 118°; (2) $[\alpha]_D$ + 142°) supported the belief that the disaccharides possessed α-linkages.

Chromatographic evidence for the constitution of the disaccharides is as follows: enzymic hydrolysis showed that each contained galactose and an N-acetylhexosamine. Reduction with potassium borohydride demonstrated that the compounds were galactosides because on hydrolysis of the reduced disaccharide

both (1) and (2) gave galactose and the alcohol of the amino-sugar component. In amyl alcohol : dioxan : water : acetic acid (43 : 34 : 23 : 0·6) solvent mixture, compounds (1) and (2), ($R_{glucose}$ values 0·68 and 0·65 respectively), ran slightly faster than β-galactosyl-(1→6)-N-acetylglucosamine[5] ($R_{glucose}$, 0·61) and more slowly than β-(1→3)-[6] or β-(1→4)-[7] galactosyl-N-acetylglucosamine ($R_{glucose}$, 0·75). An α-compound would be expected to run slightly faster than the corresponding β-compound, and this behaviour therefore suggested that (1) and (2) contained α-(1→6) linkages. This suggestion was supported by the colour reaction given with the benzidine–trichloroacetic acid spray reagent[8]. The two new disaccharides each gave a purple-brown spot which was similar in colour to that given by the β-(1→6) compound, but which differed markedly from the golden-brown colour given by the β-(1→4) compound and the greenish-brown colour observed with the β-(1→3) disaccharide. On spraying with alkali followed by Ehrlich's reagent[9] (*p*-dimethylaminobenzaldehyde) (1) and (2) both gave a purple colour indicating a (1→3) or a (1→6) linkage since N-acetylhexosamines which have no free reducing group, or which are substituted at C-4, fail to react with this reagent[10]. Pretreatment of the disaccharides with 0·05 *N* sodium carbonate for 4 min. at 100° before the chromatograms were run resulted mainly in the formation of the disaccharide chromogen without decomposition into the component sugars; this behaviour is similar to that of the β-(1→6) compound[11] and differs from the β-(1→3) which when heated under identical conditions is hydrolysed completely and gives only the chromogen of N-acetylglucosamine. The chromatographic evidence therefore points to the identification of (1) as α-galactosyl-(1→6)-N-acetylglucosamine and (2) as α-galactosyl-(1→6)-N-acetylgalactosamine. The results of periodate oxidation experiments were consistent with these structures since each compound rapidly consumed three molecules of periodate during the first hour of oxidation with a further uptake of three molecules during the next 24 hours, as would be expected for a galactosyl-(1→6)-*N*-acetylhexosamine.

A full account of this work, including the behaviour of these disaccharides in serological inhibition tests, will be given elsewhere.

I am indebted to Dr. Muriel Robertson for generous supplies of *T. foetus* organisms.

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Peculiar Distribution of the Diego Factor among the Warrau

The Warrau are a tribe of South American Indians occupying the Orinoco delta and the adjacent swampy regions of the coast of British Guiana. They have been living in this region since prehistoric times. Being a group of about 9,000 people with a culture fundamentally marginal, they belong to the earliest inhabitants as yet traceable in South America[1].

Two different expeditions were undertaken to the Orinoco delta, in the course of which blood samples were collected from two different Warrau communities: Guayo and Winikina. Genealogical and demographic studies which were executed after we had studied the blood of the Guayo–Warrau group made us suspect that these Indians had some admixture with other Indians, a fact which we then expected to account for the low incidence of the Diego factor among this group. Our expectations were realized after we had tested the Winikina. They are a subgroup stemming from a Warrau subtribe which has been living in complete isolation until very recently.

The present communication is based on 153 blood samples which we had the opportunity of collecting among the Warrau. Genealogical tables at our disposal proved the individuals not to be related with each other. As stated above, the samples were taken from two different Indian communities which are separated from each other by a distance of about 100 km.

Table 1 shows the incidence of ABO, MN, Rh, Duffy and Diego systems of both populations. The blood samples of the Winikina group were also tested with anti-U and anti-Tj^a sera.

The frequencies of ABO and Rh$_0$ grouping as listed in the chart proved to be in general accordance with previous findings[2]. The frequency of the *Fy^a* gene coincides with its high occurrence among most of the American Indians. It was a surprise, however, to find both populations with a low incidence of the gene *M*. So far, the Warrau seem to be the only tribe of American Indians known to carry the gene *M* in such a low percentage[3]. The U and Tj^a antigens were positive in all samples of the Winikina subtribe.

The outstanding result of this study was the low incidence of the Di^a antigen among the Guayo–Warrau and the complete negative finding of it among the Winikina–Warrau. The very low occurrence in the first group and negative incidence in the second group cannot be explained by interbreeding with caucasoids or negroids (among whom the Di^a antigen was found to be absent)[4] because the Warrau tested have a frequency of 100 per cent of gene *O* and a negative incidence of the *cde* and *cDe* chromosomes. It is reasonable to assume that the Diego antigen originally has been absent among these Indians and that the positive cases in the Guayo–Warrau were introduced by admixture with Indians carrying the gene; such as the Arawak and Carib, with whom the peripheral Warrau have been in contact since prehistoric times.

Besides the Eskimos[5], the Warrau are the second American tribe which so far seem to lack the Di^a antigen.

Since the incidence of ABO, Rh, Duffy and other blood groups in a great number of American Indian tribes has not shown any significant difference, it is very difficult to determine the interbreeding of two or more tribes from the point of view of blood group-

Table 1. FREQUENCY OF ABO, MN, Rh, DUFFY, DIEGO, Tj^a AND U IN THE WARRAU TRIBE

Warrau sub-tribes	No. tested	ABO system				MN system					Duffy system			
		Phenotypes (per cent)				Phenotypes (per cent)			Genes (per cent)		Phenotypes (per cent)		Genes (per cent)	
		A	B	AB	O	M	MN	N	*M*	*N*	Fy(a+)	Fy(a−)	*Fy^a*	*Fy^b*
Guayo	81	0	0	0	100	28·39	44·44	27·16	50·61	49·38	91·35	8·64	97·07	2·93
Winikina	72	0	0	0	100	15·27	43·05	41·66	36·79	63·18	97·22	2·77	98·34	1·66

Warrau sub-tribes	Rh system								Diego system				Tj^a factor		U factor	
	Phenotypes (per cent)					Chromosomes (per cent)			Phenotypes (per cent)		Genes (per cent)		Phenotypes (per cent)		Phenotypes (per cent)	
	CCDE	CCDee	CcDE	CcDee	ccDE	*CDE*	*CDe*	*cDE*	Di(a+)	Di(a−)	*Di^a*	*Di^b*	Tj(a+)	Tj(a−)	U(+)	U(−)
Guayo	2·46	45·67	45·67	3·70	2·46	1·79	67·58	30·63	3·69	96·31	1·9	98·1	Not tested	—	Not tested	—
Winikina	11·11	44·41	38·88	2·77	2·77	7·89	66·62	25·49	0	100	0	100	100	0	100	0

ing. However, the peculiar incidence of the Diego factor (negative in two, low or high in others[4]) makes it likely that this antigen could be used in future work to determine the rate of interbreeding among them. It is probable that such variable frequency might occur also in Asiatic mongoloid populations.

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Hæmoglobin E and the Diego Blood Group Antigen in Sarawak and Burma

A CONSIDERABLE number of simple genetical characters—blood groups and hæmoglobins—are known which distinguish between negroids and caucasoids, but very few have been found which are characteristic of mongoloids. The genes for the Diego (Di^a) blood-group antigen and for hæmoglobin E seem, however, to fall into the latter category.

Hæmoglobin E is characteristic of the peoples of south-east Asia and, as has been shown in preliminary surveys[1,2], the Burmese have the highest known frequency of carriers in the population (15·3 per cent, mainly heterozygotes). With the Burmese may be classed the Siamese[3] with 13·6 per cent, and the Malaysian Malays from eastern Malaya[4] with 13·1 per cent. A second group with lower frequencies includes the less-pure Malaysian Malays from other parts of Malaya[4] (5·0 per cent), the Indonesians[5] (2·6 per cent), and the Veddas[1] of Ceylon, the Bengalis[6] and the Gurkhas[7], among whom only a few instances have been recorded. Among the Chinese, however, extensive surveys have so far failed to show any hæmoglobin E at all. Relatively little work has been done on the hæmoglobins of American Indians, and no abnormal hæmoglobins have been reported in those of unmixed ancestry.

The Diego blood-group antigen was first found in a Venezuelan man[8], later shown to be probably partly of South American Indian ancestry[9]. Owing to the absence of the antigen from any of the white North Americans tested it was at first regarded as a rare familial one, but it was afterwards found to be common in Venezuelan Indians[9] and, later, in other populations. Layrisse and Arends[10] have recently reviewed the literature; combining data from papers cited by them and from other papers[11] we find the antigen to be present in 21 per cent of South American Indians, 10 per cent of North American Indians, 14 per cent of Japanese and 5 per cent of Chinese. It was not found in surveys covering 2,600 caucasoids of various nationalities, but was discovered in a Pole[12] whose wife developed the corresponding antibody through pregnancy immunization. No one with the antigen was found among 35 American Negroes, 156 Eastern Canadian Eskimos, 80 Eastern Polynesians, 162 Australian Aborigines, 23 Eastern Papuans and 74 natives of New Britain.

We have recently examined 185 specimens from Sarawak, 101 from Land Dyaks and 85 from Sea Dyaks (Iban). The Land Dyak specimens were collected from six separate longhouses (villages). The Sea Dyak ones were from recruits to the Sarawak Regiment, coming from numerous longhouses. So far as possible first degree relatives of other subjects tested were avoided. When they were examined for abnormal hæmoglobins all those from Sea Dyaks and all but one from Land Dyaks were found to contain only normal adult hæmoglobin (hæmoglobin A). The exception contained 73 per cent of hæmoglobin A and 27 per cent of a hæmoglobin having the electrophoretic properties of hæmoglobin E. The proportion of the hæmoglobin-A_2 fraction, present in minute amounts in normal blood and electrophoretically indistinguishable from hæmoglobin E, is raised in thalassæmia[13]. In the present instance, however, fœtal hæmoglobin was absent, the red cells were of normal appearance, and, as already indicated, the proportion of apparent hæmoglobin E was more than 20 per cent. From these facts, and the considerations put forward by Aksoy, Lehmann and Lie-Injo Luan Eng[14], it is virtually certain that the sample came from an *AE* heterozygote and not from a case of thalassæmia.

All the Sea Dyak specimens were tested for the Di^a-antigen, the results all being negative; most of them were tested for other blood-group antigens as well. Only 61 of the Land Dyak specimens were in a suitable state for blood grouping, and three of these were found to carry the Di^a-antigen. The full blood grouping results will be published separately.

We have also recently carried out a study of the hæmoglobins and blood groups of the Burmese, the full results of which will be published separately. Some preliminary hæmoglobin results[1,2] have been mentioned above; the full series shows the even higher frequency of hæmoglobin-E carriers of 16·3 per cent. When the main samples were collected, however, we did not have any anti-Di[a] serum and we have, therefore, more recently tested a further ten specimens with this serum, with one positive result.

The two characters under consideration, though both, broadly speaking, are confined to mongoloids, have quite different distributions. The Burmese are at or near the centre of the highest frequency of hæmoglobin E, but apparently on the western fringe of the distribution of the Diego antigen. The Land Dyaks, however, from the point of view of the two characters under consideration, may perhaps be regarded as transitional, lying near the eastern margin of distribution of hæmoglobin E but probably, like the Burmese, near the western margin of the Diego area.

The main Diego centre appears to be much farther east, but despite the small numbers tested, our results extend its known area of distribution considerably westward. It is clearly an important indicator of mongoloid ancestry, but its very high frequency among South American Indians and its apparent absence among Eskimos are surprising features which suggest that it may perhaps turn out to be an index of earliness of dispersal from some centre of mongoloid evolution. It is important that tests for this antigen should be carried out on many more Asiatic and Pacific Island populations as well as on larger numbers of Eskimos from all parts of the extensive territory in which they live. In particular, its possible extension to the west of Sarawak and Burma needs to be sought.

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Passage of Serum Albumins from the Mother to the Fœtus

It has long been recognized that mammals transmit antibodies to their young before the latter are capable of making their own. In current opinion, antibodies are accorded a special status denied to other proteins, and indeed to macromolecules generally, for only antibody protein is generally conceded to pass through the layers of cells separating the maternal and fœtal circulations without undergoing metabolic degradation.

In the rabbit, antibodies are passed to the young during intra-uterine life, a transfer which occurs mainly, perhaps exclusively, via the yolk sac rather than the placenta[1]. Even before a circulation has developed, all the main plasma proteins identified by electrophoresis are present in the yolk-sac fluid, having presumably been transferred as proteins from the maternal blood. The fate of these proteins, whether they are degraded in the yolk sac or afterwards passed into the embryonic blood or tissues, is not known. However, preliminary experiments indicated that bovine serum albumin, or some material of similar antigenicity, appears in the fœtus within twenty-four hours after intravenous injection of the protein into the mother on the nineteenth day of gestation[2]. We have now confirmed this with both bovine and human serum albumins, and have found that proteins retain their original electrophoretic characteristics after passage through several layers of maternal and fœtal tissue. Our observations also indicate that serum albumin can pass directly from the uterine lumen into the exocœle, by-passing the circulation of the yolk sac.

Dutch rabbits (2–2·7 kgm. body-weight) were injected intravenously on the nineteenth or twenty-fourth days *post coitum* with 62·5 mgm. of albumin per kgm. body-weight. Samples of maternal and fœtal blood, and of various other fœtal fluids, were taken with the aid of 'Nembutal' and ether at 1, 6, 24 and 48 hr. after injection. Maternal blood was taken from a uterine vessel, fœtal blood from a vitelline artery or the heart. The fœtal membranes were rinsed with warm saline, dried at one point so that a fine capillary showed no uptake of fluid, and a pipette inserted at the dry point. All fluids were centrifuged to remove cells and tested in two-fold dilutions with specific rabbit antisera. Samples of the fœtal fluids were subjected to electrophoresis on Whatman No. 1 filter-paper strips in veronal buffer (pH 8·6, μ 0·1) for 16 hr. at a constant current of 30 m.amp. One strip was stained with bromphenol blue, and segments of a duplicate strip were squeezed out and the fluids tested with antisera.

Substances with the antigenicity of bovine and human albumins were regularly found in the fœtal sera and migrated with the original mobility of these proteins in close proximity to the fœtal albumin (Fig. 1). Since these substances also formed precipitates with their specific antisera, it is highly probable that the two albumins were not greatly modified as a result of their passage from the mother to the fœtus and through the several fœtal compartments.

The albumins were detectable as early as one hour after injection of the mother and generally increased in concentration during the first 48 hr. (Fig. 2). Blood samples taken at 24 and 48 hr. consistently showed higher titres for the human albumin. This is in accord with the work by Brambell and his associates on the passage of human and bovine antibodies in the rabbit and support their suggestion of a

selective mechanism which favours the uptake of human over bovine antibodies. However, human albumin does not appear to be better adapted to penetrate fœtal tissues than bovine albumin. In the fluids of the exocœle, amnion, allantois, and stomach the bovine titres were generally equal to the human titres. Even the apparent selective uptake indicated for the blood vessels may be illusory, the outcome of selective elimination of bovine albumin from the blood into the exocœle. This is suggested by the blood and exocœle titres of the younger fœtuses (19 day series) at 24 and 48 hr., the drop in blood titres being accompanied by a rise in the exocœle.

A striking difference between the two fœtal stages was found in the fluids of the amnion, allantois and stomach (Fig. 2). In the younger

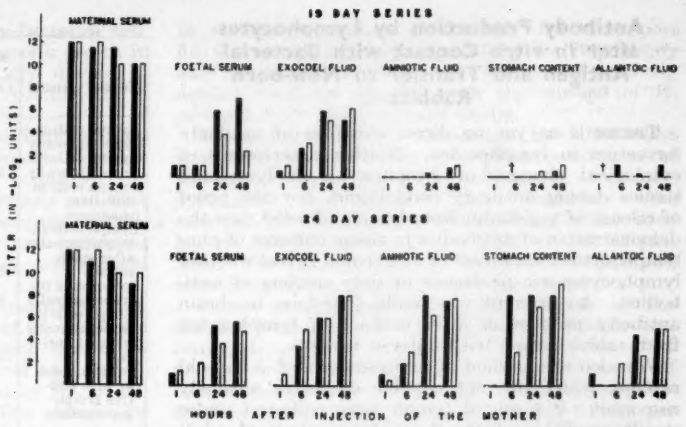

Fig. 2. Foreign albumins in maternal and fœtal fluids at 1, 6, 24 and 48 hr. after intravenous injection of the mother. Titres for human albumin (black bars) and bovine albumin (white bars) were obtained with antisera showing a titre of 1 : 1,024 when tested with standards containing 1 mgm. albumin/ml. Each bar represents the average of three to seven samples. A cross indicates no sample tested

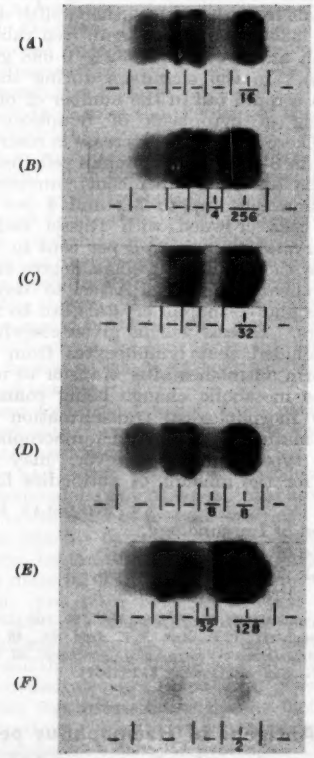

Fig. 1. Paper electrophoresis patterns of fluids from fœtal rabbits after injection of human or bovine serum albumins into pregnant females on the nineteenth or twenty-fourth days of gestation. Fractions under each pattern indicate titres for the foreign proteins, obtained from duplicate strips cut into segments (vertical lines). A dash indicates negative titre with fœtal fluid diluted 1/2. The volume of fœtal fluids subjected to electrophoresis and the proteins injected into the mother are: *A*, serum, 40 μl., human albumin, 24 days gestation; *B*, stomach contents, 100 μl., human albumin, 24 days gestation; *C*, exocœl fluid, 200 μl., human albumin, 19 days gestation; *D*, serum, 40 μl., bovine albumin, 24 days gestation; *E*, amniotic fluid, 100 μl., bovine albumin, 24 days gestation; *F*, allantoic fluid, 300 μl., bovine albumin, 24 days gestation

fœtuses these compartments showed little or no foreign protein, whereas the older ones usually had titres as high as, or frequently exceeding, those of the blood. Whatever the means by which the proteins enter or leave these compartments, it is apparent that a radical change in the permeability of the fœtal membranes must occur between the nineteenth and twenty-fourth days of gestation.

When the vitelline vessels were ligated before injection of the mother, the fœtal blood showed only traces of foreign albumin; titres in the other fœtal compartments were essentially unaffected. It is apparent that albumin, like antibodies, must to a large extent pass from the maternal into the fœtal blood via the vitelline vessels. On the other hand, the albumins can enter the exocœle and other compartments without the participation of a functional yolk-sac circulation. Direct passage into the exocœle is also supported by the observation that exocœle titres at one hour after injection were frequently higher than the blood titres, and in some instances the exocœle fluid was positive when the blood was still negative. The importance of the exocœle in the transfer of antibodies was indicated by the recent work of Brambell and Halliday[3] on the passage of anti-*Salmonella* into the rat fœtus close to term. These antibodies appear to pass successively from the uterine lumen into the exocœle, amniotic cavity, stomach and blood. Such a pathway, with the possible exception of entry into the blood, is consistent with our findings on the albumins in the 24–26 day rabbit fœtus, but not in the 19–21 day fœtus, in which the amniotic and stomach fluids showed no foreign protein or only traces at best. In both stages, however, the exocœle and the yolk-sac vessels seem to serve as primary reservoirs for the albumins taken up by the yolk sac.

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Antibody Production by Lymphocytes after *in vitro* Contact with Bacterial Antigen and Transfer to New-born Rabbits

There is as yet no direct evidence of antibody formation in lymphocytes. Neither descriptions of cytological changes of lymphocytes in lymphatic tissues during antibody production[1], nor the proof of release of γ-globulin from lymphoid cells[2], nor the demonstration of antibodies in tissue cultures of pure lymphocytes immunized *in vivo*[3] could reveal whether lymphocytes are producers or only carriers of antibodies. An attempt was made, therefore, to obtain antibody production after contact of lymphocytes from rabbit lymph with antigen *in vitro*.

We used the method of cell transfer to 2–5-day-old rabbits, which are not capable of active antibody response[4]. 2–4 ml. of lymph were collected under sterile conditions from the cisterna chyli of adult rabbits (1,500–3,000 gm.). With three exceptions, cells from each donor separately were washed three times with Hank's solution, suspended in 1–2 ml. of this solution and mixed with bacterial antigen (to *Brucella suis*, *Salmonella paratyphi B*) in the proportion of 2–6 microbes to each cell. 2×10^6 to 80×10^6 viable cells (according to the trypan-blue test) were injected intraperitoneally into each recipient. The differential counts of ethanol-fixed smears stained with methyl green–pyronine from thirteen donors showed the following estimate of the constitution of transferred lymph: blasts (probably lymphoblasts) $8{\cdot}78 \pm 0{\cdot}95$ per cent; prolymphocytes $17{\cdot}41 \pm 1{\cdot}13$ per cent; lymphocytes $72{\cdot}59 \pm 1{\cdot}38$ per cent; macrophages and monocytes $0{\cdot}76 \pm 0{\cdot}22$ per cent; granulocytes $0{\cdot}46 \pm 0{\cdot}17$ per cent. In five recipients splenectomy was performed 5 hr. before cell transfer.

In order to exclude possible participation of the recipient's tissues and to enable quantitative analysis of cell changes, in some cases the lymph cells in Hank's solution were transferred in diffusion chambers ('Plexiglass' cylinders with bases of 'Millipor' membranes of 0·8-μ porosity, content 0·4–0·6 ml.). These chambers were placed in the peritoneal cavity of recipient rabbits under ether anæsthesia.

New-born rabbits of the same litters served as controls. They received: (1) isolated spleen cells with antigen under the same conditions; (2) lymph cells without antigen; (3) cell-free lymph supernatant with antigen and (4) antigen alone in corresponding quantity. Thirty-two test animals and thirty-one controls from sixteen litters were used.

It was found that after transfer of lymph cells, antibodies appear in about 90 per cent of intact recipients (Table 1) after 2–4 days, the peak being attained after 5–8 days. There is a direct relation between the quantity of transferred cells and the antibody titre. Results on splenectomized animals suggest that, after direct injection of cells into the peritoneal cavity, antibody formation is due mainly to cells localized in the spleen. Cells in a diffusion chamber give relatively lower titres in the serum, but antibodies persist for a longer period and in higher titres inside the chamber (20 days, 1 : 16). Spleen-cell transfer results in 100 per cent antibody formation.

Other animals were examined histologically. Proliferation of the lymph cells injected directly occurs chiefly on the omentum and in the spleen within a few days. A prompt reaction of macrophages develops, together with granulation and fibrous tissue formation in the surrounding area. Clumps of immature and mature plasma cells and pyroninophil reticular cells are formed in the marginal zones of layers of transferred cells. The average spleen weight in test animals from the fifth to the twelfth day after transfer is $1{\cdot}336 \pm 0{\cdot}104$ gm./kgm. (ten rabbits), in controls with antigen only $0{\cdot}939 \pm 0{\cdot}098$ gm./kgm. (ten rabbits). In the chambers during the initial proliferation a rapid fall in the number of blast cells and shedding of cytoplasm of lymphocytes was observed. There is a definite increase in macrophages (22 per cent in 8 days), pyroninophil cells resembling reticular cells (up to 1·6 per cent), immature and mature plasma cells (up to 3·2 and 4 per cent in 4–8 days), cells crowded with Russel bodies and eosinophil crystals (up to 28·8 per cent in 8 days). In controls without antigen a slight degree of plasma cell development occurred. After 45 days, only macrophages and eosinophil crystals can be found in the chambers. Details will be given elsewhere.

Table 1

Mode of transfer	No. of cells ($\times 10^6$)	No. of recipients	Distribution of agglutinating titres						
			0	2	4	8	16	32	64
Lymph cells intraperitoneally	2–20	5	1	1	1	2	—	—	—
Lymph cells intraperitoneally	20–80	13	2	—	1	3	2	4	1
Lymph cells in diffusion chambers	2–20	9	—	—	4	2	3*	—	—
Lymph cells intraperitoneally after splenectomy	20–80	5	5	—	—	—	—	—	—
Spleen cells intraperitoneally	20–80	16	—	—	1	3	5	4	3
Lymph cells intraperitoneally without antigen	20–80	6	6	—	—	—	—	—	—
Antigen alone or with cell-free lymph supernatant	—	9	9	—	—	—	—	—	—

* 75×10^6 cells in two cases

It is concluded that lymphocytes from cisterna chyli can form antibodies after transfer to new-born animals, the metabolic change being connected or followed by morphological transformation of some of the less-mature cells into the macrophage and plasma-cell types which, however, may not be responsible for the amount of antibodies formed.

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Surface Antigens of *Haemophilus pertussis*

It has been shown by Frappier and Guérault[1,2], and Frappier, Guérault and De Repentigny[3], that the antigen of *Haemophilus pertussis* which protects mice against intracerebral infection could be washed off the bacteria by saline (0·85 per cent sodium chloride). As this protective effect in the mouse is accepted as an indicator of the efficiency of vaccines in protecting children against whooping-cough it would appear that saline washings afford a ready means of obtaining the immunizing antigen of the

organism free from the bulk of the bacterial cell. The washings were obtained from bacteria grown in a fluid medium, they were practically devoid of toxicity and stimulated agglutinin production in rabbits.

We have in general confirmed these findings using cultures from Bordet Gengou (*BG*) medium. Further observations showed that washings contained the histamine sensitizing factor of *H. pertussis* and that rabbit antiserum prepared against washings neutralized the histamine sensitizing factor and protected mice passively against intracerebral and intratracheal infection with *H. pertussis*.

The properties enumerated for washings were demonstrated also with an extract of *H. pertussis* obtained by treating the organisms with a mixture of solvents, consisting of thiourea, urea and formamide, according to a method employed by Dr. B. W. Lacey (personal communication). The extract so obtained had a high protective value for mice.

Extraction by a mixture of thiourea, urea and formamide removed more material than treatment with saline. The dry weight of the extract was greater than that for washings. Extracted bacteria were devoid of the histamine sensitizing factor whereas it was present in saline-washed bacteria. Although extracted bacteria still had agglutinogen and protected mice against intra-cerebral challenge, rabbit antiserum prepared against them was weak in passive protection of mice.

These findings raise the problem of the identity of the immunizing antigen of *H. pertussis* and its possible relationship with the histamine sensitizing factor or agglutinogen. The absence of the histamine sensitizing factor in extracted bacteria which retained their agglutinogen and their ability to protect mice (although probably somewhat reduced) might be interpreted as dissociating the antigen responsible for histamine sensitization from the agglutinogen and immunizing antigen. This may eventually be proved to be the case; but the result just noted could be due to differences in the threshold for detecting different biological effects rather than the operation of different entities.

We have found that serum from persons hyperimmunized with commercial pertussis vaccines contained anti-histamine sensitizing factor as well as agglutinin and mouse protective antibody.

For chemical examination of the antigens concerned it is desirable to prepare washings or extracts as free as possible from extraneous material. With *BG* medium bacterial growth was contaminated with antigenic material from the medium as was demonstrated by precipitin reaction in agar gel. This source of impurity was reduced by growing cultures on 'Cellophane' disks applied to the surface of *BG* medium, and this technique has been adopted throughout our investigations. In cultures grown on bare *BG* medium the histamine sensitizing factor diffused into the medium, but this was largely prevented by using 'Cellophane'. Bacteria grown on 'Cellophane', and washings from them, had more histamine sensitizing factor than was obtained from growth on the bare medium. Some mouse protective antigen escaped into the medium without 'Cellophane', and this too was avoided if 'Cellophane' was used, but the amount was not enough to make a detectable difference in the capacity of the bacteria to immunize mice against intracerebral challenge.

These findings suggest that the histamine sensitizing factor, agglutinogen and protective antigen may be surface components of the cell. Direct support for this view has been obtained by De Repentigny and Frappier[4], who found that fluorescent antibody against washings reacted with the surface of *H. pertussis* from liquid or solid media.

Examination of the washings by ultra-violet spectroscopy showed an absorption maximum at 265 mμ corresponding with nucleic acids or purine–pyrimidine constituents. These materials were removed by dialysis from the washings which then had an absorption spectrum similar to that of proteins. The dialysed washings retained their histamine sensitizing and mouse protective properties.

Paper chromatography of hydrolysates of the dialysed washings and extract showed an amino-acid composition typical of proteins. Glucosamine, often present in protein–lipid–carbohydrate complexes of bacterial origin was also found. Freeze-dried preparations gave a total nitrogen value of 9·5–14 per cent. Reducing substances accounted for 5–10 per cent of the weight of dialysed extract. Small amounts of glucose and galactose were detected. These results were consistent with the presence of a protein–lipid–carbohydrate complex in the dialysed washings or extract.

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Antigenic Formulæ for the Genus *Clostridium*

ANTIGENIC formulæ for *Clostridium sporogenes*, *Clostridium histolyticum* and *Clostridium parabotulinum* were devised by Mandia and Bruner[1] and by Mandia[2–4]. These were restricted to the heat-labile antigens and excluded the *O*- and the spore- (*S*-) antigens.

It is, however, no longer possible to ignore the antigenicity of the spore which was demonstrated by Defalle[5] as early as 1902. Howie and Cruickshank[6] confirmed this antigenicity with a relatively pure suspension of *Cl. sporogenes*, and laid down the principles of setting separate spore and vegetative antigen–antibody systems.

These principles have been used for devising spore and vegetative agglutination and agglutinin-absorption tests, using 37 *Clostridium septicum* and 35 *Clostridium chauvoei* strains isolated in Britain, France and the United States. The two organisms appeared to share a common spore (*S*)-antigen, and no cross-agglutination occurred between their vegetative antigens. All *Cl. chauvoei* strains shared the same *O*-antigen, but possessed two different *H*-types. There was complete identity between the *O*-antigens of types I and III and types II and IV of *Cl. septicum*, and varying cross-agglutination, but no agglutinin-absorption, between their 5 *H*-types.

These results explain earlier contradicting reports on varying cross-agglutination between *Cl. septicum* and *Cl. chauvoei*. The antigenicity of the spore, previously attributed to the vegetative forms, no doubt depended on the degree of sporulation of the cultures and the methods used by the different

workers in preparing the antigens. Fuerth[7] and Conradi and Bieling[8] have, however, described a 'spore' as well as a 'vegetative cycle' for *Cl. septicum* and *Cl. chauvoei*; and Kreuzer[9] affirmed the presence of a common heat-stable antigen between them.

I am of the opinion that all classification within the genus *Clostridium* should be firmly based on antigenic characters. These are the most reliable, and the more stable, of all the criteria we now possess. The use of antigenic formulæ comprising the *S*-, the *O*- and the *H*-antigens would simplify their identification, as well as overcome any difficulty of antigenic overlapping between the different species.

Similar investigations are now being made to extend the work to other *Clostridia*.

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An Improved Technique for Spot Testing, using a 'Cellophane' Membrane

If the coloured compound in a spot test is allowed to form within a 'Cellophane' membrane instead of on filter paper, the colour can be seen much more clearly, and colour comparison is greatly facilitated. The procedure is described below for the formation of salicyloylhydrazones by aldehydes and ketones[1], but is of general application.

A test-tube containing a few drops of the carbonyl compound (if it is volatile) is covered with a sheet of 'Cellophane' previously moistened with 5 per cent aqueous acetic acid, and the 'Cellophane' is firmly secured with a rubber band. A drop of a saturated solution of salicyloylhydrazide in 5 per cent acetic acid is put on the 'Cellophane', through which it permeates to meet the carbonyl compound penetrating from the other side by volatilization. Interference from non-volatile substances is avoided, and, since the volatile substance is virtually sealed in, contamination of neighbouring tests is prevented. Excess reagent can be removed by simply wiping the outer surface of the 'Cellophane' with a damp cloth.

The method can be used for non-volatile substances, for example, oxosteroids, by placing a 5 per cent aqueous acetic acid solution of them in the 'Cellophane'-capped tube. The test-tube is inverted so that the lower surface of the 'Cellophane' is wetted, and a drop of reagent put on the top surface as before.

The new technique can be applied to all colour reactions which take place in aqueous solution. Non-waterproofed 'Cellophane' must, of course, be used.

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Generation and Propagation of Impulses during Refractoriness in a Pacinian Corpuscle

Deformation of mechano-receptors gives rise to generator potentials which in turn eventually set up propagated potentials. In order to analyse generator potentials it is desirable to block the propagated potential. In the Pacinian corpuscle this may be done by the aid of drugs, by changing the ionic environment of the receptor[1] or, as here reported, by taking advantage of differences in duration of the refractory period of generator and propagated events. Generator potentials alone are obtained when the deformation of the receptor occurs during the refractory period of the propagated potential.

Pacinian corpuscles of the cat's mesentery were isolated, together with a length of afferent axon[2,3], and set up in a bath containing an oxygenated Krebs's solution covered with mineral oil. The electric activity of the sense organ was led off between the Krebs's–oil interface, serving as fluid electrode, and a platinum electrode placed on the axon at some distance from the corpuscle. For recording of generator potentials, the interface was adjusted to lay at the site of the axon's emergence from the corpuscle. Graduable mechanical stimuli were provided by the deflexions of a piezo-electric crystal, applied to the corpuscle by a glass stylus[3]. The stylus's movements were followed photo-electrically, and were found to follow up to 1,000 pulses/s. with fidelity.

When two mechanical stimuli of threshold strength are successively delivered to the corpuscle at an interval longer than 10 msec. (relative refractory period), each stimulus causes the firing of a propagated potential. Upon progressive reduction of stimulus interval the threshold for setting up a propagated response rises[3–5]. At the same time, the propagated potential falls gradually to 75 per cent of its resting magnitude, and finally becomes abruptly blocked within the corpuscle. A non-propagated all-or-nothing potential, presumably corresponding to activity of the first intracorpuscular node of Ranvier, is then detected. This potential declines gradually as the interval is progressively shortened, and finally vanishes leaving a graded potential (generator potential) as the only response to mechanical stimuli. This potential increases as a function of stimulus strength, without changes in latency.

A generator potential leaves a refractory state behind, so that the amplitude of a second generator potential falling on its refractory trail is directly related to the time elapsed after the first. Unlike the propagated potential, the generator potential decreases gradually to zero as the stimulus interval is progressively shortened, revealing no sign of absolute refractoriness. Furthermore, the amplitude of a refractory generator potential is inversely related to the magnitude of the preceding generator response[1]. However, the size of the generator potential is independent of the refractory state left by a preceding propagated potential. For example, the amplitude of a generator potential in response to the second stimulus belonging to a pair of stimuli, remains the same whether preceded by a generator potential or a four times greater propagated potential. Had the latter been an equally large generator potential, the second generator potential would have become considerably reduced. This independence between generator and propagated

events may be regarded as a further argument for spatial and functional differences in their origin[4,6].

For a given stimulus interval the minimal amplitude of generator potential at which firing of propagated potentials occurs (firing height) is fairly constant. The firing height increases progressively as the interval is shortened during the relative refractory period. The increase in firing height and the reduction in amplitude of the refractory generator potential determine the threshold rise during the corpuscle's relative refractory period.

The generator potential set up in response to a single mechanical stimulus decays to zero in 4–8 msec. The decay time is constant for a given receptor and is independent of duration of stimulus. However, the spontaneous decay of generator potential is not due to the receptor's incapacity for sustaining a generator potential, since with repetitive mechanical stimulation of the corpuscle at, for example, the rate of 900 stimuli per second a generator potential is built up which shows no decline over 100 msec. of observation. A mechanical component in adaptation[7] may account for the spontaneous decline in generator response.

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Variations in Axonal Diameters of Myelinated Nerve Fibres: Apparent or Real?

IN a paper read to the Anatomical Society of Great Britain and Ireland on November 29, Miss B. Higgs, of the Royal Free Hospital School of Medicine, put forward clear evidence that fixatives may affect the relative diameters of a nerve fibre in the nodal and internodal regions. Although readily accepting her findings, which provide at least a partial explanation for the differences in axonal diameters seen in fixed material, it is obvious that such a fixation artefact cannot explain the apparent diameter variations recorded as existing in living nerve fibres by de Renyi (1929).

It had occurred to me that the highly refractile myelin sheath might act as a lens and magnify the internodal portions of axon, making them seem abnormally wide in comparison with the uncovered axon in the nodal regions. To illustrate this point, on the same day I showed to the Society a lantern slide depicting a simple piece of apparatus which I had made. This consisted of a black rod (axon) partially enclosed in a water-filled glass tube (myelin sheath). The enclosed portion of rod presented a diameter some 30 per cent greater than the un-enclosed portions (Fig. 1). It may well be that a myelin sheath would indeed act in this way in living tissue,

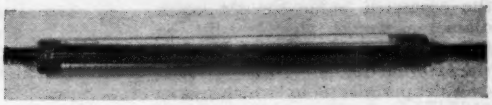

Fig. 1

and it is possible that 'fixed' myelin may have an even higher refractive index and produce even greater magnification of the internodal portions of the axon.

Since nerves are extensile structures then they must possess the ability to recoil. This property may be invested, in part at least, in the myelin sheath; and, in teased preparations, the myelin sheaths, by virtue of this recoil mechanism, may cause actual shortening and broadening of the internodal axoplasm without exerting a similar effect on the nodal axoplasm.

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QUANTITATIVE histological methods are employed in the study of the myelinated fibre population of peripheral nerve and frequently a histogram is constructed to demonstrate the myelinated fibre diameter size frequency distribution. For this purpose fibres are grouped according to calibre, based upon measurements of diameter of the whole fibre, including the myelin sheath. Within any fibre group the relation of the axonal diameter to that of the total fibre is thought to be relatively constant. Thus, for fibres of 10–12μ, the proportion of axonal to external diameter is usually considered to be 0·7 : 1. This ratio was obtained by Donaldson and Hoke[1], and later workers[2,3], using stained transverse sections of fixed nerve, and by de Rényi[4] using intact, unfixed fibres. The results of both these techniques need correction, the former for distortion inherent in the fixation and subsequent processing, and the latter for optical effects.

When fresh teased preparations of peripheral nerve are examined microscopically, measurements of axon diameter are affected by the optical properties of the highly refractile myelin sheath and of the immersion medium. At the mid-internodal region the basic problem is that of an axon within a cylindrical convex lens of myelin surrounded by immersion fluid. The interfaces to be considered are: (i) myelin – immersion medium; and (ii) immersion medium – air.

Experiments were conducted using normal saline *as the immersion fluid and lecithin as the lens matrix*, the optical properties of lecithin being comparable to those of the myelin sheath[5]. Determinations of the individual refractive indices of these media gave the following values for the effective indices operative at the interfaces when considering an emergent beam: interface i, 0·89; interface ii, 0·75.

Sample measurements made on a preparation of mammalian nerve teased in normal saline: external diameter, 11μ; apparent axon diameter, 8μ. The receiving angle of the objective used, under the conditions of the experiment, was 45°. Theoretical consideration of the myelin lens system and the appropriate refractive indices, involving the construction of scale diagrams, showed that the virtual images produced by the axonal margin lie on a curve. If the most lateral point on this curve is considered, the magnification of the system is 20 per cent. Thus

the corrected value for the axon diameter would theoretically be 6·7μ and the ratio of the axonal to the external diameter, 0·6 : 1. However, experiments in which nerve fibres were immersed in fluids of different refractive indices suggest that the refractive index of myelin considered in relation to a radial optic axis is rather higher than that of lecithin, and therefore the corrected ratio would be even lower.

This low ratio, at variance with that obtained for fibres of similar size in fixed preparations, receives confirmation from the work of one of us (P. L. W.). Measurements of axonal and external diameter have been made using thin transverse sections of fresh, unfixed peripheral nerve. In such preparations, using orthodox forms of illumination, fibres in the range 10–12μ show a ratio of axonal to external diameter of 0·45–0·60 : 1 (mean 0·51 : 1). However, preliminary observations using interference and polarizing techniques indicate that even this ratio may need further reduction. Details of the technique used and full results will be published elsewhere.

The problem thus far has been simplified; it is in fact much more complex. The ultra-structure of myelin, and thus its optical properties, vary[5]. In addition one must consider the possible effects of the immersion medium on the properties of myelin[5,6]. The thickness of the myelin sheath varies not only with fibre diameter[2,3,7] but also in different regions of the same fibre. Differences in thickness and curvature are most obvious in the paranodal region[8].

It is hoped to evolve a correction factor of more general application.

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Apparatus for Stimulation of Insect Sense-Organs by Air Puffs

During work on the relation of acetylcholine to nervous activity in insects[1,2] an apparatus was devised for the stimulation of the sensillæ of the cerci of *Periplaneta americana* L. by puffs of air. Since the apparatus allows separate control of strength, duration and frequency of the puffs of air, it is felt that it might find applications in other problems. The apparatus consists of an electronic switch controlling a solenoid valve through which compressed air is led to the point of application. A pressure regulator in the air line determines the strength of the puffs of air, while the duration and frequency are determined by the electronic switch. The operation

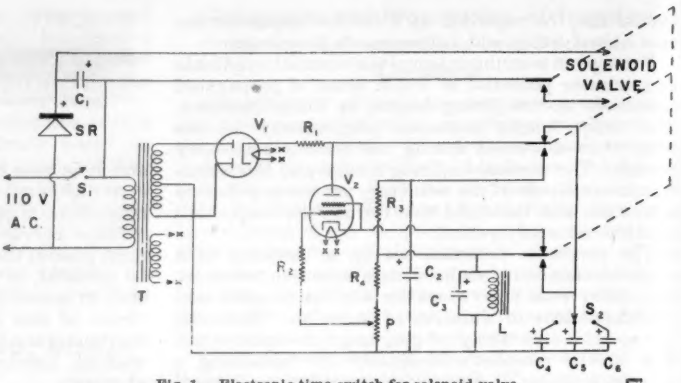

Fig. 1. Electronic time-switch for solenoid valve

C_1 80 mfd. electrolytic 150 w.v.	*SR*	Selenium rectifier 250 m.amp.	130 V.
C_2 20 mfd. electrolytic 250 w.v.	*XX*	6·3 V.	
C_3 2 mfd. electrolytic 250 w.v.	R_1	250 ohms	5 watts
C_4 10 mfd. electrolytic 250 w.v.	R_2,R_3	100 K.ohms	½ watt
C_5 20 mfd. electrolytic 250 w.v.	R_4	33 K.ohms	½ watt
C_6 40 mfd. electrolytic 250 w.v.	*P*	100 K.ohms	potentiometer
T 'Hammond 269*B*', 150–0–150 V.	V_1	6*X*5	
L 'Guardian' relay, 5,000 ohms, 4 PDT	V_2	2*D*21	

of the electronic switch (Fig. 1) is as follows. Firing of the thyratron V_2 causes a surge of current through the relay *L*, depressing the three contacts. This activates the solenoid valve, charges condenser C_2, cuts out V_2 and allows C_5 (or C_4 or C_6, according to the setting of S_2) to discharge through *L*. The relay armature remains in this position for a period determined by the LC_5 time-constant and then returns to its normal or upper position, closing the solenoid valve, recharging C_5 and reconnecting V_2. The voltage on C_2 now leaks off through R_2, R_4, *P* and *L*, producing a slowly decaying bias on V_2 (which may be altered by the setting on *P*) until V_2 again fires, repeating the cycle. Thus the setting on *P* determines the time during which the solenoid valve is closed, while the capacity of the condenser selected by S_2 determines how long it is open. The potentiometer *P* provides intervals from 0·45–8·0 sec., the calibrated scale being slightly expanded in the lower range, while with S_2 times of 0·13, 0·25 and 0·56 sec. were obtained. Other time-intervals are possible by altering the capacity of condensers C_2 to C_6.

Smoother and quieter operation of the Skinner electric solenoid valve (supplied by Minneapolis-Honeywell Regulator Co., Philadelphia 4, Pennsylvania) results from the use of direct current supplied by the selenium rectifier *SR*. Noise from valve operation, which in itself causes sensory stimulation, is eliminated by encasing the valve assembly in a rubber-mounted wooden box lined with two inches of fibre glass.

In a typical experiment puffs of air were led by a plastic tube to a glass tip mounted behind the roach cerci. Nerve activity was recorded with a 'Tektronix' Type 512 oscilloscope and a 'Fairchild' camera. The control unit for the camera was activated through a fourth contact on relay *L*, thereby synchronizing the camera operation with a puff of air.

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Silicate in the Metabolism of *Azotobacter vinelandii*

MOLYBDENUM complexed as silico-molybdate has been shown to be very active in the re-activation of aldehyde oxidase from which the molybdenum has been removed by dialysis[1]. Other reports have implicated silicate, phosphate and other anions as agents which increase the activity of molybdate-dependent enzymes[2,3]. Jacobs and Sanadi[4] suggested that a silico-molybdate complex was involved in a terminal electron transport system that was coupled with phosphorylation. It was shown by Glenn and Crane[5], however, that the *in vivo* functioning of aldehyde oxidase was probably not dependent on silico-molybdate even though it did greatly enhance the activity of the *in vitro* system.

It has already been shown that *A. vinelandii* is capable of incorporating into molybdo-protein as much as 100 times more molybdate than is required for optimum rate of growth[6].

We were led to consider the possible relationship of silicate and molybdate in the metabolism of *Azotobacter* by the observation that 100 p.p.m. germanium (as germanate) inhibits the growth of *Azotobacter* by 30–50 per cent. Because germanium is in the same chemical group as silicon it seemed possible that germanium was acting as an inhibitor of a silicate function much as tungstate inhibits molybdate function[6].

We therefore measured the uptake of silicate directly by the use of silicon-31 prepared from reagent grade silica gel (Mallinckrodt) by neutron bombardment. (Reactor facilities were provided by the Battelle Memorial Institute.) The irradiated silicon-31 was fused with sodium carbonate in a platinum crucible according to standard methods[7,8]. Half-life determinations showed the material to be about 99·9 per cent radiochemically pure.

Under culture conditions (in Burk's[9] nitrogen-free medium) such that *A. vinelandii* cells would take up nearly all the 1 p.p.m. molybdenum added to the culture, only 0·2 p.p.m. silicon-31 was taken up and only one-fourth of this was retained when the whole cells were washed thoroughly. When the molybdate-level of the medium was decreased so that the quantity of molybdate taken up decreased by a factor of 100, there was no change in the uptake of silicon-31. Furthermore, germanium at a level of 100 p.p.m. had no influence on the uptake of silicon-31, or molybdenum-99. Silicate concentrations also had no effect on the uptake of molybdenum-99.

The distribution of the silicon-31 retained by the cells in centrifugal fractions of these cells after sonic disruption was examined. In contrast to the published[10] distribution of molybdenum, in which both the highest total (more than 65 per cent) and highest specific activity of molybdenum-99 are found in a fraction sedimentable at 144,000*g*, only 5 per cent of the retained silicon-31 was found in the corresponding sedimentable fraction. The supernatant fraction contained 85 per cent of the total silicon-31, and the specific activity was 3½ times greater in the supernatant fraction than in any other.

As a result of the lack of correlation between the behaviour of silicon-31 and molybdenum-99 in these uptake and distribution studies in *Azotobacter vinelandii*, it is concluded that silicate is not involved in the molybdate metabolism of these cells as a silico-molybdate complex anion. Further, even though germanate does inhibit the growth of *Azotobacter*, it has no effect on the uptake of silicate.

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Absorption and Distribution in Rats of Radioactive Phosphorus biologically incorporated in Food

IN this investigation absorption and distribution of phosphorus-32, biologically incorporated into fish muscle and bean leaves, was compared with its absorption after feeding as inorganic phosphate. Within limits of error, no differences were detected.

The experimental animals were 179 young adult female Sprague–Dawley rats (wt.-range 190–304 gm.: mean wt. 238 gm.) maintained *ad lib.* upon a Purina Lab Chow diet. The following solutions and suspensions containing radioactive phosphorus were administered orally to these animals:

(1) *Inorganic phosphorus*: 100 rats received 1 ml. of a *p*H 2 solution containing 25 μc. phosphorus-32 ($Na_2H^{32}PO_4$) and less than 0·6 μgm. of non-radioactive sodium hydrogen phosphate.

(2) *Fish protein phosphorus*: 51 rats received 2 ml. of a water/whitefish muscle homogenate (1/1, w/w) which had a concentration of a 0·5 μc. phosphorus-32 per ml. The muscles were derived from a fish which 72 hr. previously had received an intraperitoneal injection of 10 mc. of inorganic phosphorus-32.

(3) *Plant leaf phosphorus*: 28 rats received 1 ml. of a water/bean leaf homogenate (1/1, w/w), which contained 3·3 μc. phosphorus-32 per ml. It was prepared from leaves of young red kidney bean plants grown in an appropriate nutrient culture medium containing radioactive phosphorus-32.

Excreta were collected individually from each of eight animals of the inorganic phosphorus-32 group over a period of 40 days following the feeding. In the other two experimental groups, excreta were collected from each of eight animals up to 20 days following feeding.

The experimental animals were killed in groups of four at time-intervals ranging from 3 hr. to 40 days following radioisotope administration. The concentrations of phosphorus-32 in aliquots of blood, femur, liver, and excreta were determined. In order to measure the overall distribution of phosphorus-32 and total inert phosphorus[3] in the entire skeleton and teeth, a $Na_2H^{32}PO_4$ solution was orally administered to 17 additional young female rats. Three of these

Table 1. Distribution of Phosphorus-32 following Oral Administration

Tissue / Day	Administered dose/tissue (per cent)			
	Blood*	Liver	Fæces†	Urine
1	0·7	3·6	28·2	6·9
5	0·3	1·7	36·0	12·8
10	0·2	0·9	39·8	15·6
20	0·1	0·4	43·6	18·7
40	0·1	0·1	46·9	21·7

* Total blood percentages are calculated on the basis of total rat blood volume of 5 per cent body-weight.

† Excreta are cumulative totals through experimental day indicated.

animals were killed at 6 days, and fourteen were killed 12 days after the feeding. These time differences did not appear to influence the phosphorus-32 concentrations of bones and teeth.

Although statistical analysis of the radioactivity values, corrected for decay and self-absorption, showed significant differences between groups of rats fed radioactivity from the same food source, none could be assigned to the effects of the radioactive food source itself. Real differences among results obtained from animals receiving the same treatment may have masked inter-treatment differences for the intra-treatment variations appeared to be related to the time when the experiments were performed. The lack of any effects ascribable to differences in the food forms in which phosphorus-32 was fed strongly suggests that phosphorus derived from animal or plant sources is absorbed and utilized very similarly to phosphate ion. For this reason results from each feeding group were combined and are summarized in Table 1. After the first ten days of the experimental period the rate of excretion of phosphorus-32 in fæces was equal to that in urine. Assuming that this equality was closely related to excretion of *absorbed* phosphorus-32 the earlier excess of phosphorus-32 in fæces, as compared to urine, was taken as the *unabsorbed* fraction of the fed dose. On this basis about 75 per cent of the administered phosphorus-32 was absorbed—a confirmation of results of other investigations[2]. Table 1 shows that by the tenth day more than 95 per cent of the unabsorbed phosphorus-32 had appeared in the fæces, while a combined total of more than 50 per cent of the total fed was excreted in urine and fæces together.

No statistically significant changes with time in deposition and retention of phosphorus-32 by bones and teeth were found, and mean values are summarized in Table 2. The total skeletal concentration of phosphorus-32 was 13·5 per cent of the administered dose, a value from 40 per cent to 70 per cent less than those reported previously[3–5]. Comparison of the total skeletal phosphorus-32 to the phosphorus-32 content of the relatively accessible femur yields a factor of 24·6 ± 1·2. The mean concentration of phosphorus-32 in bone was more than twice that of the molar teeth, but less than a third that of the incisors. The average of 10·8 per cent stable phosphorus-31 in bone is considerably higher than the 8 per cent reported for rat bone in a previous study[6], but is close to a 10·4 per cent reported for human bone[7]. The non-radioactive phosphorus content of the teeth types was higher than the bone value, but accords with the 13 per cent reported previously for rat incisor[8], and is also within the range of values reported for human enamel and dentin[7]. These differences between bone and tooth concentrations of phosphorus-32 and phosphorus-31, reflected in their phosphorus-32/phosphorus-31 ratios, may be accounted for by differences in growth-rates of these tissues[9].

Table 2. Distribution of Phosphorus in Bone and Teeth

Tissue / Isotope	Bone*	Molars	Incisors
Phosphorus-32 (per cent dose/gm.)	0·9 ± 0·05†	0·4 ± 0·1	3·4 ± 1·0
Phosphorus-31 (gm./100 gm.)	10·8 ± 0·6	13·3 ± 0·9	13·5 ± 1·2
Phosphorus-32/phosphorus-31 (per cent dose/gm.)	8·3 ± 0·04	3·0 ± 0·6	25·2 ± 6·7

* Total phosphorus-32 of skeleton amounted to 13·5 per cent of administered dose. Femur contained a total of 0·55 ± 0·04 per cent of dose.

† Values are means ± standard deviation.

We gratefully acknowledge our debt to J. H. Rediske and R. C. Pendleton for supplying the phosphorus-32 labelled bean leaves and whitefish muscle; to Joan Hess, Alma Crosby, and members of the Biology Control Operation for skilled technical assistance; and to H. T. Norton and D. W. Gaylor for statistical analysis of the experimental results.

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Hydrogen Peroxide and Tumour Therapy

Ten rats were implanted with Walker tumour and on the same day and succeeding days of the experiment the drinking water was replaced by 0·45 per cent hydrogen peroxide as described by Holman[1]. They all died at the same time (13–14 days) with tumours of the same weight (25–34 gm.) as in the ten control rats. Another transplantable tumour, the Sheffield *Rd*/3 sarcoma, was also used in an exactly similar experiment except that there were 6 rats per group. In the peroxide group all died at 16–21 days (tumour-weight 38–46 gm.) and in the control group receiving tap water there was one natural regression and the remaining 5 died at 16–21 days (tumour-weight 32–39 gm.). We have had a long experience with the actions of possible chemotherapeutic agents on these tumours, and they are responsive to some of

them. We can assert confidently that in the environment of the University of Sheffield Field Laboratories this particular treatment is completely ineffective.

Much earlier experiments, made for other reasons, in which spontaneous and transplanted tumours were injected intratumorally with various concentrations of commercial hydrogen peroxide at intervals from an early stage of growth, were all essentially negative.

Holman makes no reference to the behaviour of his tumour when implanted into control untreated rats. From our own experience we know that even normally highly transplantable tumours occasionally pass through phases when the incidence of natural tumour regression is substantial. In view of this we feel that the 'cures' obtained by Holman may have been, in fact, natural tumour regressions.

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Development of Eggs before the Final Moult in *Pratylenchus*

Among nematodes separated from soil about the roots of Grenache vines in February 1957 were females of *Pratylenchus* which carried eggs at their tails, outside the body but within a partly cast cuticle. Six specimens were recovered from a few pounds of soil. The life-cycle of a typical *Pratylenchus*[1] includes four moults from egg to adult, the first moult occurring in the egg, where the second-stage larva may be distinguished by the appearance of a well-defined buccal spear. In each of these specimens the egg contained a clearly differentiated second-stage larva. The cuticle of the nematode was detached at the head region and at the rear of the body from a point anterior to the vulva. Many normal specimens of *Pratylenchus* were also present, and one apparently larval female carried an egg with a second-stage larva in the oviduct.

Three of the specimens with eggs at the tail were kept in a dish of water. Two died within a few days, but the third emerged about half-way from the old cuticle before death.

Ten similar specimens were recovered from samples taken at the same site about a month later. One of these carried two fully differentiated eggs within the old cuticle. Two specimens showed no differentiation in the eggs—just a number of cells. All showed displacement of the cephalic cap, which indicated commencement of moulting. One specimen which started to emerge from the old cuticle was transferred to a slide, and under the slight pressure of the cover-glass the nematode completed the moult in a few minutes, surviving for about a week on the slide. The egg with cast cuticle was retained for more than a fortnight in water, but did not hatch.

It appears that females of this species may, in certain circumstances, produce eggs before the final moult takes place. Eggs thus produced cannot be laid in the normal way as there is no adequate aperture at the vulva for them to pass the larval cuticle. The eggs are retained in the body, and may undergo considerable development, until the final moult commences. When the cuticle begins to separate from the body, the egg can pass the vulva, and finds its way to the tail within the cuticular sac. Completion of moulting releases the egg. Although the one egg obtained free from these specimens did not hatch, these eggs may normally be viable. However, the fact that so many of the eggs observed were at an advanced stage of development suggests perhaps that hatching has been inhibited.

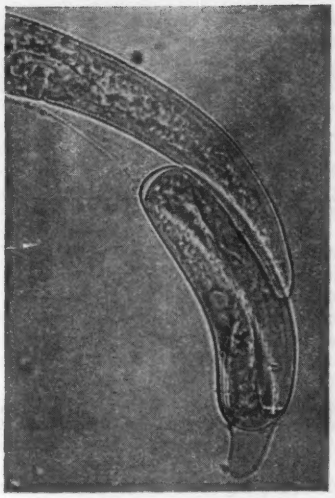

Fig. 1. Tail of *Pratylenchus minyus* showing egg retained by partly cast cuticle

Little is known of the mechanisms which control development in plant parasitic nematodes. It cannot be judged whether development of the reproductive system has been accelerated, or whether moulting has been retarded in these specimens, but the two processes are obviously not interdependent. No treatment other than normal vineyard practice has been applied to the area from which these nematodes were taken.

The species concerned is morphologically similar to *Pratylenchus minyus* Sher and Allen[2], but no males have been found.

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Light Reactions of Littoral Gastropods

Molluscan behaviour has attracted the attention of many workers, and the literature contains several references to the homing ability and direction finding in various gastropods[1]. Light is acknowledged as an important factor in such mechanisms in numerous invertebrates, and recently the plane of polarization of light has been shown to be an operative factor in the orientation of *Eupagurus bernhardus*[2], the xiphosuran *Limulus*[3], some hymenopterous and lepidopterous larvæ[4], and various insects[5].

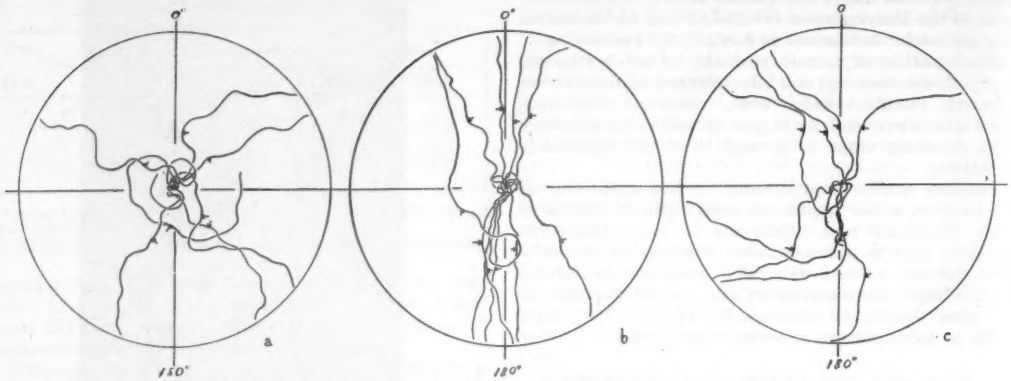

Fig. 1. Tracks under sea water: (*a*) non-polarized light, ← rotation of 'Polaroid' holder; (*b*) polarized light, 'Polaroid' momentarily turned through 90° and back again, ← rotation of 'Polaroid'; (*c*) polarized light, 'Polaroid' turned through 90° and left there, ← rotation of 'Polaroid'

During an investigation of the behaviour of several species of *Littorina* to various stimuli, it was found that *Littorina littoralis* (L.) (=*obtusata*) gave a very strong light compass reaction. This species was then tested with plane polarized light as follows. A disk of 'Polaroid' some 4 in. in diameter was mounted in front of a 500-W. source of light fitted with a heat filter. The whole apparatus was aligned with the optical axis vertical to the plane upon which individual specimens of *Littorina* were allowed to crawl. The plane of polarization was freely adjustable by rotation of the 'Polaroid' disk. Experiments were carried out on more than 150 specimens moving in air and under water. The track of each specimen was plotted as it moved, so that all its movements from the instant of illumination were recorded.

Three experimental conditions were applied: (*a*) The plane of polarization of the light was maintained along the reference axis. After the animal had traversed a standard distance from the starting point, the plane of polarization was momentarily rotated through 90° and returned to its original direction; (*b*) the plane of polarization was rotated through 90° from the reference axis after the animal had traversed the standard distance, and left in its new position; (*c*) the same as for (*a*) and (*b*) but with non-polarized light.

Fig. 1, *a*–*c*, shows a random selection of tracks obtained under water by the above treatments. A comparable series was obtained in air.

The results are summarized in Tables 1 and 2. All the angles indicated are angles of deviation of the tracks from the reference axis. These results were shown to be highly significant by the χ^2 test and prove that *L. littoralis* orientates itself along the plane of polarization of light falling on it from above.

Further experiments are planned to investigate how the eye detects the plane of polarization of light

Table 1. *Littorina littoralis* (L.) immersed in Sea Water

Angles given are deviations from the original plane of vibration of light (reference axis)

Treatment	0–30° 150–180° 180–210° 330–360°	30–60° 120–150° 210–240° 300–330°	60–90° 90–120° 240–270° 270–300°	No. circling	Total No. tested
Group *A*. Plane of vibration constant along 0–180° reference axis					
First half of track before rotation through 90°	37	6	1	6	50
Second half of track after rotation through 90°	40	3	1	6	50
Group *B*. Plane of vibration rotated through 90°					
First half of track before rotation through 90°	35	9	—	6	50
Second half of track after rotation through 90°	7	18	19	6	50
Group *C*. In non-polarized light	10	17	10	13	50

Table 2. *Littorina littoralis* (L.) in Air

Angles given are deviations from the original plane of vibration of the light (reference axis)

Treatment	0–30° 150–180° 180–210° 330–360°	30–60° 120–150° 210–240° 300–330°	60–90° 90–120° 240–270° 270–300°	No. circling	Total No. tested
Group *A*. Plane of vibration constant along 0–180° reference axis	81	7	2	—	90
Group *B*. Plane of vibration rotated through 90°					
First half of track before rotation through 90°	83	6	1	—	90
Second half of track after rotation through 90°	13	26	51	—	90
Group *C*. In non-polarized light	24	30	25	11	90

and the relationship of this reaction with the other light reactions that this species exhibits.

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Neuro-Anatomical Site in Tick Paralysis

Previous studies[1] have shown that tick paralysis, induced in mongrel dogs by applying the wood tick *Dermacentor andersoni* Stiles, is due to failure in transmission at the neuro-muscular junction because: (*a*) the anterior tibial muscle in a paralysed dog responded to direct but not to indirect stimulation through the peroneal nerve; (*b*) the motor nerve fibres conducted an impulse.

More recent investigations have demonstrated the following: The muscle contracts on rapid close intra-arterial injections of acetylcholine; neostigmine does not facilitate transmission in a fully paralysed muscle and causes only a slight improvement in a partially paralysed one; neither cathodal nor anodal current facilitate transmission in a fully paralysed muscle; the paralysis is intensified by curare, but is uninfluenced by pentamethonium; tetanization via the nerve slightly facilitates transmission of subsequent individual pulses in both the partially and completely paralysed muscle and in the former the tetanus is well maintained. These results indicate that the neuro-muscular block is dissimilar to that produced by the competitive and depolarizing blocking agents and anticholinesterases.

Functional activity of the end-plates is indicated by (*a*) contraction of the muscle on close intra-arterial injection of acetylcholine, (*b*) their depolarization by succinylcholine.

Table 1 shows the response of the normal, partially and completely paralysed anterior tibial muscle to close intra-arterial injections of acetylcholine. Increasing paralysis apparently produces an increasing sensitivity of the muscle to acetylcholine, the paralysed muscle behaving like a denervated one.

End-plates could be located in the paralysed anterior tibial muscle by sweeping its undersurface with a wick electrode after an injection of succinylcholine, the technique being similar to that described by Burns and Paton[2]. Usually four or more end-plate regions could be located in this way. The depolarizing effect of the succinylcholine was then permitted to wear off. In an apparently paralysed muscle, usually one or more muscle fibres contracted on nerve stimulation and the site of minimum latency of the action potential corresponded to only one of the located end-plate regions. Neither action nor end-plate potentials could be detected at the other located end-plate regions. The findings suggest that the probable mechanism for the paralysis is due to failure in the liberation or synthesis of acetylcholine at the nerve terminals.

Table 1. Sensitivity of Anterior Tibial Muscle to Rapid Close Intra-arterial Injection of Acetylcholine

Anterior tibial muscle	No. of experiments	Approximate average dose (μgm.) of acetylcholine to produce	
		Threshold contraction	Contraction = maximal muscle twitch
Normal	4	5	50
Partially paralysed	3	1	15
Fully paralysed	1	?	1

In an attempt to localize exactly the site of the neuro-muscular block, the anterior tibial muscle was stimulated directly in a completely paralysed animal before and after the administration of curare. No difference could be detected in the magnitude of the mechanical responses indicating that the block is probably located at the nerve terminals in contradistinction to that in botulism poisoning, where the block is evidently proximal to the terminals[3].

The only effective method, known to date, of producing tick paralysis is by applying the wild ticks. When a saline extract (1 gm./ml.) of 128 engorged female ticks removed from paralysed dogs was injected intra-arterially (3 ml. × 1 ml.) and intravenously (1, 10 and 10 ml.) into a normal anæsthetized dog, it produced no detectable effect on the mechanical response of the anterior tibial muscle during indirect stimulation. Evidently continuous secretion of a 'toxin' by the ticks is necessary to produce paralysis because rapid recovery occurs on removal of the ticks.

As the tick 'toxin' appears to interfere with the liberation of acetylcholine at the neuro-muscular junction, one might expect that it would also interfere with acetylcholine liberation at other sites, for example, ganglionic and neuro-effector cholinergic junctions. Stimulation of the central end of the cervical sympathetic, proximal to the superior cervical ganglion, resulted in a normal dilation of the pupil and retraction of the nictitating membrane in a paralysed dog and stimulation of the peripheral end of the vagus in the neck caused normal cardiac slowing. In addition, if acetylcholine liberation in sympathetic ganglia was diminished in a paralysed animal one might expect to find a low blood pressure. The blood pressure in five paralysed dogs were within normal limits (130, 150, 100, 170 and 190 mm. mercury). Evidently the tick 'toxin' exhibits a specific predilection for the neuro-muscular junction.

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Anthocyanins in Blackcurrant Fruits

Robinson and Robinson[1] investigated the anthocyanin pigments of the fruit of the blackcurrant (*Ribes nigrum*) and stated that the skins contained a cyanidin-3-bioside. Cyanidin was the only aglycone found; but it was thought possible that small amounts of delphinidin were present. Fouassin[2] has recently examined blackcurrant pigments by paper

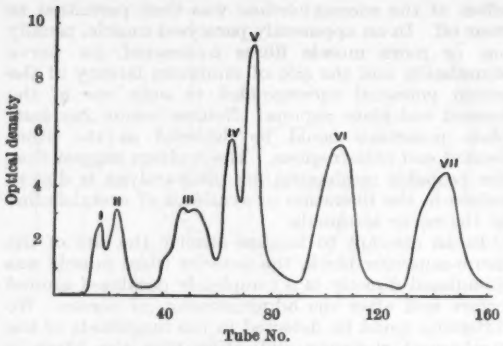

Fig. 1. Optical density at 545 mμ of blackcurrant anthocyanins eluted from a cellulose column

chromatography and has found two glycosides of cyanidin and two glycosides of delphinidin.

In the present investigations, extracts of blackcurrants in methanol containing 1 per cent hydrochloric acid have been shown to contain seven pigments, separable by cellulose column chromatography, using the organic phase of butanol/2*N* hydrochloric acid (1 : 1) as solvent. Whatman standard-grade cellulose powder, sieved to obtain the fraction larger than 200-mesh and smaller than 100-mesh, was packed in the solvent to give a column 50 × 4·4 cm., using a stainless-steel tamper to ensure even packing. The crude anthocyanin, approximately 0·7 gm., precipitated by ether from the methanolic extract, was dissolved in 40 ml. of the solvent, and this concentrated solution fed to the top of the column. The eluate was collected automatically in 10 ml. fractions. The graph of optical density at 545 mμ plotted against the tube number (Fig. 1) shows the presence of seven distinct bands.

To concentrate the slower-running bands (Fig. 1, IV, V, VI and VII), each eluate was mixed with an equal volume of acetone and adsorbed on to another cellulose column. The original solvent was washed off with acetone and the anthocyanins eluted with 0·1 per cent methanolic hydrochloric acid which was then readily removed under vacuum. The faster-running bands (Fig. 1, I, II and III) were not held tenaciously enough by the column to permit this procedure. Therefore, basic lead acetate was added to each eluate to form the lead complex which was then decomposed with methanolic hydrochloric acid and the solution filtered and evaporated to dryness. The residues were dissolved in 1 per cent hydrochloric acid and concentrated hydrochloric acid was added to make the final concentration 20 per cent. The solutions were stored in the refrigerator, and after several days the precipitated pigments were recovered.

Band I appeared on the column as a brownish front to band II, and it is considered to be a degradation product. The other bands fell into two groups of three on the basis of visual colour, bands II, IV and V being scarlet and bands III, VI and VII crimson. By comparison with known samples on paper chromatograms it was found that the material from band II was cyanidin, and the anthocyanins from bands IV and V yielded cyanidin on hydrolysis. Similarly, band III was found to be due to delphinidin and bands VI and VII to delphinidin glycosides.

After hydrolysis of the mixed anthocyanins from blackcurrants, glucose was the only sugar detected by paper chromatography. The anthocyanin from band V was shown to be chromatographically identical with chrysanthemin (cyanidin-3-glucoside) isolated from the petals of mauve chrysanthemums[2] and purified by passage through the cellulose column. The other cyanidin glucoside from band IV, after partial hydrolysis by boiling in 5 per cent hydrochloric acid for 30 min., was converted to a pigment chromatographically identical with chrysanthemin. Since a test[1] for acyl groups was negative it appears that the anthocyanin from band IV is a cyanidin diglucoside, possibly a 3-bioside as proposed by Robinson and Robinson[1] or the 3,5-diglucoside although its R_F values (Table 1) do not agree with those given by Bate-Smith[4].

Table 1. R_F Values of Blackcurrant Pigments

Band	Solvent system			
	Butanol/acetic acid/water (ref. 4)	Butanol/2 *N* hydrogen chloride (ref. 4)	*m*-Cresol/acetic acid/water (ref. 4)	Forrestal solvent (ref. 5)
II	Fades	0·74	Fades	0·47
III	Fades	0·44	Fades	0·30
IV	0·38	0·31	0·38	0·75
V	0·40	0·28	0·47	0·71
VI	0·25	0·19	0·14	0·67
VII	0·18	0·14	0·17	0·62

Partial hydrolysis of the delphinidin glucoside from band VI converted it into an anthocyanin identical with that from band VII. The R_F values (Table 1) of these two anthocyanins do not correspond with published values[4], but it is probable that they are a mono- and di-glucoside respectively of delphinidin. It is hoped to confirm the structure of these glucosides and the cyanidin diglucoside by synthesis.

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Selective Uptake of Radiochemical Impurities by Mitochondria

When using potassium-42 to trace the exchange of potassium in a suspension of non-metabolizing mitochondria from rat liver, specimens were obtained in which the specific activity of mitochondrial potassium appeared greater than the specific activity of the separated labelling medium. The radioactive material used was spectroscopically pure $^{42}K_2CO_3$, which had been irradiated for one week at the Atomic

Table 1

	Potassium (μequiv./ml.)	Radioactivity (counts/min./ml.)	Apparent specific activity (counts/min./μequiv.)
Suspending medium	136·5	$1·77 \times 10^7$	$1·30 \times 10^5$
Washed mitochondria	0·098	$1·92 \times 10^4$	$1·96 \times 10^5$

Mitochondria were prepared by differential centrifugation in 0·25 *M* sucrose + 0·025 *M tris* buffer at pH 7·0. After suspension in 0·15 *M* KCl + ^{42}K for 60 min. at 0° C., mitochondria were washed three times with sucrose-*tris*.

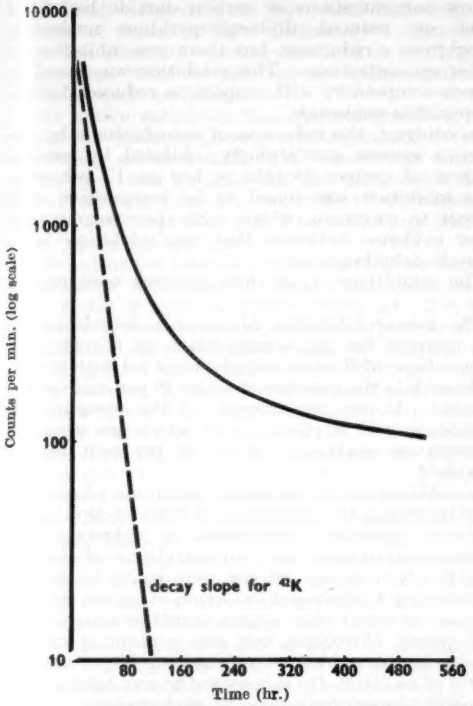

Fig. 1. The unbroken line represents the radioactive decay of the contaminants 'bound' to the mitochondria

Energy Research Establishment, Harwell. When measured on a *M*6 ('20th Century Electronics') Geiger–Müller counter, the apparent specific activity (counts/min./μequiv. potassium) of potassium on the labelled mitochondria was 1·5 times as great as that of potassium in the labelling solution (Table 1). On further investigation it was found that the decay of activity on the mitochondria corresponded to a half-life greater than 12·4 hr. (see Fig. 1).

The $^{42}K_2CO_3$ was found to contain several isotopes of half-life greater than 12·4 hr. The major contaminant has a half-life of approximately 30 hr. and occurs to the extent of 1 part in $2{\cdot}6 \times 10^4$ as measured by the *M*6-counter at the time of removal of the $^{42}K_2CO_3$ from the pile. Several other radioactive isotopes, of half-life between 10 and 25 days, were detected, and these amounted to 1 part in $6{\cdot}4 \times 10^5$. Slater[1] has shown that isolated muscle mitochondria have a high affinity for calcium: and the selective adsorption of the long-life isotopes by the liver mitochondria (Table 2) suggested that the contaminants were multivalent cations. This was confirmed by their behaviour on a column of cation exchange resin.

Table 2. Ratio of Potassium-42 to Radioactive Contaminants

Suspending medium	10,000 : 1
Washed mitochondria	1 : 1

The available evidence strongly suggests that the contaminant of 30-hr. half-life is barium-135 and this should be removed from a solution of ^{42}KCl by adding barium chloride and a stoichiometric amount of sulphuric acid. This technique fails to remove other contaminants, and has the additional disadvantage of introducing trace amounts of Ba^{2+} (0·02 mequiv./l.) and SO_4^{2-} into the solution. A more satisfactory separation was achieved by eluting the potassium-42 from a cation exchange resin *IR* 120 (*K*) with 0·15 *M* potassium chloride.

A column (10 cm. × 1 cm.) of *IR* 120 (*H*) was treated with 20 ml. of 30 per cent potassium chloride (KCl) to convert it to the *K*-form. After washing with 200 ml. of distilled water, 60 ml. of 0·15 *M* ^{42}KCl was put down the column at 0·8 ml./min. The column was rewashed with 30 ml. of distilled water to remove anionic isotopes present and then treated with 300 ml. of 0·15 *M* potassium chloride solution. This brings off virtually all the potassium-42, and the most active fraction has about 70 per cent of the specific activity of the original material; 90 per cent of the original activity was recovered in 120 ml. of the eluate. Mitochondria labelled with this material showed no measurable deviation over a period of 40 hr. from the decay expected of potassium-42.

It is possible that biological material other than mitochondria may selectively accumulate substances present as impurities. The effect may be quite striking; in labelled mitochondria the ratio of contaminant to potassium-42 was ten thousand times greater than in the suspending medium. It is therefore desirable that radiochemical purity should be checked by observation of the labelled biological material itself and not merely of the original stock of radioisotope. This investigation was supported by the Endowment Fund of the Manchester Royal Infirmary and by the Rockefeller Foundation.

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Some Effects of Carbon Dioxide–Bicarbonate Mixtures on the Oxidation and Reduction of Cytochrome *c* by *Ricinus* Mitochondria

The observation that the succinic oxidase system of *Ricinus* mitochondria is inhibited by concentrations of carbon dioxide above about 20 per cent[1] has led us to investigate the effects of carbon dioxide on components of the respiratory chain.

Mitochondrial preparations from the endosperms of germinating castor oil beans[2] were diluted 8–10 times with ice-cold demineralized water and incubated at 0° for 30 min. to render the mitochondrial oxidase and reductase systems accessible to cytochrome *c*. In the resulting preparations the activities of succinic cytochrome *c* reductase, reduced diphosphopyridine nucleotide cytochrome *c* reductase and cytochrome *c* oxidase were determined by spectrophotometric measurement at 550 mμ of the oxidation and reduction of cytochrome *c*. The concentrations of carbon dioxide in the reaction mixtures were regulated[3] by the addition of the calculated amounts of a 0·32 *M* solution of sodium bicarbonate which had been equilibrated against a gas mixture containing 90 per cent carbon dioxide and 10 per cent oxygen at 25°, at which temperature all measurements were made. The *p*H of the carbon dioxide–bicarbonate mixture was 7·4. We shall refer the reaction rates simply to the carbon dioxide concentrations. This is convenient, since the results to be recorded may help to explain certain metabolic disturbances and growth responses

of plant organs placed in atmospheres enriched with carbon dioxide. However, some of the effects may be due to the equilibrium concentration of bicarbonate ion.

For the measurement of succinic cytochrome *c* reductase activity, spectrophotometer cells contained 0·1 ml. of enzyme, 0·1 ml. of 2-amino-2-hydroxymethylpropane-1 : 3-diol (*tris*) buffer (20 per cent w/v, *p*H 7·4), 0·1 ml. of cytochrome *c* ($9·4 \times 10^{-4}$ *M* in 1 per cent *tris* buffer, *p*H 7·4), 0·1 ml. of cyanide (2×10^{-3} *M*, *p*H 7·4), 0·05 ml. of succinate (1·2 *M*, *p*H 7·4), and the required amount of 90 per cent carbon dioxide–bicarbonate mixture in a total volume of 3 ml. The reaction was started by the addition of succinate. For the measurement of reduced diphosphopyridine nucleotide cytochrome *c* reductase, succinate was replaced by 0·05 ml. of reduced diphosphopyridine nucleotide ($8·4 \times 10^{-3}$ *M*). For measurement of cytochrome *c* oxidase activity the reaction mixture was composed of 0·1 ml. of enzyme, 0·1 ml. of *tris* buffer, the required volume of 90 per cent carbon dioxide–bicarbonate mixture, and 0·2 ml. of reduced cytochrome *c* ($4·7 \times 10^{-4}$ *M* in 1 per cent *tris* buffer) in a total volume of 3 ml. The reaction was started by the addition of reduced cytochrome *c*. Readings were taken at 15-sec. intervals for 2 min. It was not considered necessary to equilibrate the final reaction mixture with an atmosphere containing the appropriate concentration of carbon dioxide as it had been previously ascertained that for the short period of the experimental measurement the error resulting from the diffusion of carbon dioxide was negligible.

In Table 1 the rates of each of the three reactions studied at different concentrations of carbon dioxide are given as percentages of the rates in air. The control rates in air were 10·4 μmoles cytochrome *c* reduced/hr./gm. of fresh tissue for succinic cytochrome *c* reductase; 15·8 μmoles cytochrome *c* reduced/hr./gm. of fresh tissue for reduced diphosphophyridine nucleotide cytochrome *c* reductase; and for cytochrome *c* oxidase, *k* the first-order velocity constant, was 7·54/hr./gm. of fresh tissue. Cytochrome oxidase was stimulated at the lower concentrations of carbon dioxide, with a maximum rate at about 20 per cent carbon dioxide, and was inhibited at the higher concentrations. Using different experimental conditions, Miller and Evans[4] have examined the effects of bicarbonate on cytochrome oxidase of root mitochondria. They obtained similar results, although the stimulation at low concentrations was less marked. They found larger increases in rate with sodium chloride, nitrate or sulphate, which suggests that the stimulation at low bicarbonate (or carbon dioxide) concentrations is a non-specific salt effect.

Table 1. Activities in the Presence of Carbon Dioxide relative to Those in Air

Carbon dioxide concentration (per cent of 1 atmosphere)	Succinic cytochrome *c* reductase	Reduced diphosphopyridine nucleotide cytochrome *c* reductase	Cytochrome *c* oxidase
0·05 (air)	100	100	100
1·7	—	101	109
4·3	102	110	118
8·7	75	102	135
13·0	—	—	193
17·3	38	108	265
26·0	22	88	248
43·3	14	75	124
60·7	3	44	56
78·0	—	33	25

Low concentrations of carbon dioxide had little effect on reduced diphosphopyridine nucleotide cytochrome *c* reductase, but there was inhibition at higher concentrations. This inhibition was found to be non-competitive with respect to reduced diphosphopyridine nucleotide.

In contrast, the reduction of cytochrome *c* by the succinic system was strongly inhibited by concentrations of carbon dioxide as low as 17 per cent. This inhibition was found to be competitive with respect to succinate, which with spectroscopic and other evidence indicates that the inhibition is of succinic dehydrogenase.

The inhibitions of all three systems were reversible.

The strong inhibition of succinic dehydrogenase can account for the accumulation of succinate in preparations of *Ricinus* mitochondria fed with Krebs-cycle acids in the presence of about 20 per cent carbon dioxide[1]. It can also account for the accumulation of succinic acid in plant organs which are stored in atmospheres containing about 20 per cent carbon dioxide[5,6].

In addition to the increased inhibition of succinic dehydrogenase, the inhibitions of reduced diphosphopyridine nucleotide cytochrome *c* reductase and cytochrome oxidase by concentrations of carbon dioxide above about 40 per cent could be factors contributing to the rapid induction of carbon dioxide zymasis[7] in intact plant organs stored in atmospheres with plenty of oxygen but also containing carbon dioxide in concentrations approaching 50 per cent[7–9].

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Mycobacillin, a New Antifungal Antibiotic produced by *B. subtilis*

During the studies on the distribution of antifungal organisms in Indian fruits, vegetables and soils, a strain of *Bacillus subtilis* (characterized according to Bergey[1]), highly active against widely different groups of fungi, namely, skin pathogens, plant pathogens, rice-spoilage organisms, etc., was isolated[2].

The optimum cultural conditions for the formation of the antibiotic were studied[2] and the highest yield was obtained in a medium consisting of potato extract, casein hydrolysate, beef extract and glucose. The antibiotic was extracted from the fermentation

broth and isolated in a pure state following the method of Babad *et al.*[4]. Ultimately a light-brown mass was obtained which crystallized on cooling and evaporation from 70 per cent alcoholic solution as needle-shaped crystals.

The active substance was chromatographed by a simple one-dimensional strip technique using different developing solvents, and, in all cases, only a single active spot was detected by bio-autographic technique. Several common methods of homogeneity studies also indicated the absence of any inactive impurity in the antibiotic.

The substance was soluble in lower alcohols, acetone, acetic acid, caustic soda, conc. hydrochloric acid, pyridine and in water above *p*H 7·0, but insoluble in water between *p*H 2–7 and also in ether, chloroform, etc. It gave negative Molisch and ninhydrin tests, but positive tests for Millon's reagent, biuret reaction, Folin's phenol reagent and xanthoproteic acid reaction. The substance was more heat-stable in acidic than in alkaline *p*H. The antibiotic contained no sulphur or halogens, and its nitrogen content was 11·9 per cent. Its molecular weight as determined by diffusion method was found to be of about 1,800. It has no activity against *E. coli*, *Staphylococcus aureus*, *Streptococcus fæcalis*, etc.; but it possesses a wide antifungal spectrum and it inhibits the growth of *A. niger* at 0·02 mgm./ml. in solid agar medium. Paper partition chromatography of an acid hydrolysate of the antibiotic with two-dimensional method using phenol–water as the first solvent and *n*-butanol–acetic acid–water (4 : 1 : 1) as the second solvent indicated the presence of seven amino-acids, namely, aspartic acid, glutamic acid, serine, alanine, tyrosine, leucine and proline—aspartic acid being present predominantly. The antibiotic is a ninhydrin–negative cyclic polypeptide and is somewhat different from the other known antifungal antibiotics[5] like bacillomycin, bacillomycin *B*, *C*, etc., as regards the nature and number of amino-acids present. This new antifungal antibiotic has, therefore, been designated as 'mycobacillin'.

A more detailed report will be published elsewhere.

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Maceration of Plant-tissues with Ethylene-diamine-tetra-acetic Acid

For many years plant anatomists have used macerating techniques[1–3] which subject plant-tissues to either destructive oxidizing agents (usually chromic acid), concentrated acid or alkali, or high temperature. These procedures can cause change in volume of the cells. Macerating media containing chromic acid have been found to destroy cell-walls[3] and the other media referred to above would also be very damaging to plant-cells.

The chelating agent, sodium ethylene-diamine-tetra-acetate, has been found to macerate effectively under conditions (*p*H 7–10, 37–45° C.) which are much milder than those mentioned above. This reagent should be particularly useful for maceration of tissue composed of easily damaged cells and for maceration without change in cell-volume. The macerating action of sodium ethylene-diamine-tetra-acetate is attributed to the ability of the reagent to dissolve the insoluble salts of pectic and low-methoxyl pectinic acids which appear to form a large part of the middle lamella.

The macerating power of sodium ethylene-diamine-tetra-acetate was markedly affected by changes in *p*H. The optimum *p*H for maceration of matured apple-tissue at 45° C. was 10·3. At *p*H 7 and *p*H 11·3 the macerating activity was about 50 per cent of that at *p*H 10·3. Increase in temperature greatly accelerated the rate of maceration. Although the macerating action of the reagent (0·07 *M*; *p*H 10) was appreciably weaker than that of 5 per cent chromic acid, when compared at 37° C. sodium ethylene-diamine-tetra-acetate was 250–300 times more effective than 0·07 *M* ammonium oxalate—an established macerating agent showing appreciable activity only at 100° C. If the osmotic pressure of the 0·07 *M* solution of sodium ethylene-diamine-tetra-acetate was adjusted by addition of sucrose to equal the diffusion-pressure deficit of the cells, maceration of cortical apple tissue could be achieved at 37° C. and 45° C. without detectable change in cell-volume.

For maceration of apple tissue with this reagent the two conditions found most satisfactory are described below. Mid-cortical tissue (1 gm.; cork-borings of 4–5 mm. diameter and length 4–10 mm.) was added to 50 ml. of 0·07 *M* reagent (*p*H 10·7–11·0; adjusted to the correct sucrose-concentration, 0·25–0·40 *M* depending on fruit-maturity). After being shaken continuously for 6 hr. at 45° C., the mixture was left for 16 hr. at 45° C., reshaken by hand and blended at low speed (4,000 r.p.m., M.S.E. micro-homogenizer) for up to 3 min. The blending time required varied with maturity of the fruit. Ripe fruit required no blending. The blendor-blades were covered with water-proof adhesive plaster, and the blendor-cup had baffles inserted into the bulb. The *p*H of macerates was about 10·3. Damage due to sampling of the tissue with the cork-borer accounted for all the damaged cells in the macerates. In macerates of ripe fruit, 80 per cent of the total cells were present as single cells. This procedure was satisfactory for maceration without change in cell-volume.

Maceration with sodium ethylene-diamine-tetra-acetate at 75° C. for 6 hr. with occasional shaking, followed by blending for 1–4 min. has been used for determining the number of cells in apple tissue. In these macerates 88–95 per cent of the total cells were present as single cells.

Carrot-root and potato-tuber tissue (length × diameter of borings = 3 mm. × 5 mm.) can be macerated by the above procedures (the reagent at *p*H 10). The numbers of single cells (expressed as a percentage of total cell-number) in macerates of these tissues obtained by the first method (three-minute blending) are listed below.

Carrot (central cylinder)	66
Carrot (cortex)	27
Potato (tuber)	92

Aggregates composed of more than four cells were seldom found in these or in apple macerates.

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Culture of *Nitrosomonas europaea* in Media Free of Insoluble Constituents

Since Winogradsky's discovery of *Nitrosomonas* in the latter part of the nineteenth century, members of this genus have been grown in a variety of culture media containing insoluble constituents, the most common of these being calcium carbonate. This component serves as a means of *p*H control necessary because of the accumulation of large amounts of nitrous acid and also can provide the inorganic carbon source necessary for the autotrophic metabolism of these bacteria. Eventually, it was tacitly assumed that these micro-organisms require adsorption to particulate medium ingredients in order for active proliferation to occur[1,2]. This phenomenon takes on practical significance for soil nitrification in view of the demonstration that substrate ammonium apparently must first be adsorbed before oxidation can commence[3].

In our studies of the biochemical properties of the nitrifying bacteria, it became readily evident that it would be a difficult procedure to separate the cellular material once it became embedded in the excess of insoluble carbonates and phosphates. In order to obtain quantities of cells free of chemical contamination and to determine if there was some obligate adsorption requirement, studies of the growth of these bacteria were initiated using a medium all of the constituents of which were soluble. *Nitrosomonas europaea* was grown in a 30-litre fermentor similar to that described by Johnson[4]. Air sterilized by filtration through sterile cotton or glass wool was dispersed through a 'Selas 01' candle filter. The medium contained 3·0 gm. ammonium sulphate as the energy source, 500 mgm. potassium hydrogen phosphate, 50 mgm. hydrated magnesium sulphate, 4 mgm. hydrated calcium chloride, 100 μgm. chelated iron (Chel–138–HFe, Geigy Chemical Company, New York), and 50 μgm. cresol red in a litre of redistilled water. Additional ammonium–nitrogen was added aseptically in increments as needed. After autoclaving, the medium was brought to *p*H 8·0 with a sterile potassium carbonate solution, and the culture was maintained at that reaction during the growth-cycle by continuous addition of a sterile 50 per cent potassium carbonate solution, the indicator simplifying this operation.

In the growth-cycle, a lag phase of 10 hr. was observed when a 5 per cent inoculum was used. Following the initial lag, the culture grew at a logarithmic rate for 60 hr. with a generation time of 11 hr. The final nitrite-level at 96 hr. was 1,160 p.p.m. and the corresponding viable count was $1·9 \times 10^8$ cells per ml. The problem of *p*H control is indicated by the fact that the acid produced in the last 24-hr. period required 6·3 gm. potassium carbonate per litre of medium for neutralization. The relatively short generation time observed and the accumulation of nitrite in concentrations greater than that usually found in media with insoluble carbonates demonstrate that the bacterium can develop at an optimal rate in clear media. Thus, it is evident that these organisms can grow without being adsorbed on to insoluble materials.

The bacterial cells can be separated from the medium by passage through a Sharples centrifuge with the resultant residue consisting of cells devoid of chemical impurities. The cell paste obtained represents a dry-weight yield of about 72 mgm. per litre of culture medium. The colour of this paste is deep red, probably resulting from the presence of a strong cytochrome absorption band. A more complete account of this work will be reported elsewhere.

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Effect of Plasmolysis on the Rate of Respiration of a Green Alga

In some recent experiments to be reported more fully elsewhere, the effect of plasmolysis and of temperature on the rate of respiration of the green alga *Scenedesmus quadricauda* has been investigated. The results may be summarized as follows: (1) At 25° C. there is a highly significant (probability 0·1 per cent or less) decrease in the rate of respiration on plasmolysis, with subsequent recovery on deplasmolysis. (2) At 7° C. there is no effect of plasmolysis on the rate of respiration. (3) Between 5° and 15° C. the activation energy for respiration is of the order of 21,000 cal./mole. (4) Between 15° and 35° C. the activation energy for respiration is of the order of 5,600 cal./mole. These results are independent of the presence or absence of glucose, though above 15° C. the rate of respiration is increased on the addition of glucose, whereas the rate is unaffected below this temperature.

The values of the activation energies suggest that below 15° C. a chemical reaction is limiting the rate of respiration; but above this temperature the rate is limited by the diffusion of a respiratory intermediate. In this case the effect of plasmolysis must be on the diffusion path.

Plasmolysis involves a dehydration of cellular material, and loss of water may occur either from the vacuole or from the protoplasm, or from both. Even if the total loss of water is from the vacuole, the excreted water must pass through the protoplasm, the water content of which may vary until equilibrium is regained. This will be especially true if the permeabilities of the plasma membrane and the vacuolar membrane to water are different. Further, if the plasma membrane and the vacuolar membrane both act as semi-permeable membranes towards the water in the protoplasm and the vacuole, and if there is no

movement of solute across the membranes, one would expect water to be lost from both the protoplasm and the vacuole. In cells without or with only very small vacuoles (such as *Scenedesmus quadricauda*) there is likely to be a greater loss of water from the protoplasm in hypertonic solutions than in fully vacuolated cells.

Dehydration of the protoplasm will result in an increase in its viscosity, and this has been demonstrated by Fritsch and Haines[1] for terrestrial algae drying in a desiccator. Under the same conditions, Fraymouth[2] has demonstrated a decrease in the rate of respiration. After centrifuging *Scenedesmus quadricauda* cells for 45 min. at 4,000 r.p.m., a number of larger particles were found to be displaced in normal cells but not in plasmolysed cells, indicating that some increase in viscosity had taken place in the plasmolysed cells.

The equations of Sutherland[3] and of Einstein[4] show that when the radius of the diffusing molecule is large in comparison with the radius of the solvent molecule, the rate of diffusion is proportional to the viscosity of the medium. Stiles[5] held that experimental data disproved these equations, but the data he quoted refer to the diffusion of ions in aqueous solution, and this state of affairs lies outside the Sutherland–Einstein equations. Hitchcock[6] has shown that for diffusion in aqueous solution a molecule will obey the theoretical equations provided that it is no smaller than a hexose molecule.

It is therefore suggested that the decrease in the rate of respiration observed on plasmolysis under conditions where diffusion is limiting the rate of respiration, is caused by a reduction in the rate of diffusion brought about by an increase in the viscosity of the protoplasm. There appear to be two main points in the respiratory mechanism where diffusion in the protoplasm could limit the rate of respiration. The first is diffusion of glucose-1-phosphate, formed by hydrolysis of starch, from the starch grains to the glycolytic system; and the second is the diffusion of the product of glycolysis to the mitochondria. With regard to this suggestion it is interesting to recall that an increase in the viscosity of homogenates has been found to decrease their rates of respiration[7].

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Escape Responses of Herbivorous Gastropods when stimulated by Carnivorous Gastropods

Bullock[1] reported that many Californian Gastropoda respond to being touched by tube feet of starfish by crawling rapidly away from the starfish. He also showed that the response differs in details between genera, and between species of a genus; and that some species do not respond at all, or only occasionally. In some species of *Acmaea*, and in *Haliotis cracherodii* Leach 'mushrooming' (raising of the shell well clear of the substratum on the fleshy stalk of the visceral hump) accompanied by lateral swinging of the shell occurred before the animals crawled away; in others, notably the trochid *Tegula*, the animals merely glided rapidly away from the source of stimulation.

Comparable responses may be produced by stimulating herbivorous gastropods with carnivorous ones. This was first observed in Nature on a dry rock surface which had recently been left by the receding tide. A thaisid whelk, *Lepsia haustrum* (Martyn) crawled towards a trochid *Melagraphia aethiops* (Gmelin), and as soon as contact was made between the soft parts of the two the shell of the trochid was lifted well clear of the substratum and swung violently several times through an arc of 180°. The trochid then set off across the rock at two to three times the normal crawling speed. The thaisid did not follow. This has been observed several times. Occasionally, swinging of the shell to left and right is sufficiently violent not only to break contact, but also to dislodge the carnivore, which is several times larger than the trochid.

Similar results were obtained using the starfishes *Coscinasterias calamaria* (Gray) and *Astrostole scabra* (Hutton) as stimulators. The common New Zealand littoral starfish *Asterina regularis* Verrill does not elicit any response. Since making the first observations under natural conditions, many encounters have been 'staged' in tidal pools and in laboratory aquaria. It has been found that freshly collected animals respond in a more marked fashion than those kept in aerated sea water for a few days. As in Bullock's work the vigour of the response varied somewhat between species. The more vigorous reaction involving mushrooming does not always occur; the most common reaction being an abrupt turning away from the point of stimulation, and rapid crawling away from the carnivore. If an animal is stimulated on the right side it turns left and moves away in that direction, and *vice versa*. When contact is frontal the herbivore backs away a short distance before turning to one side and crawling rapidly away. If stimulated repeatedly the herbivores used in the experiments crawled out of the pools or up the sides of the aquarium.

The reactions described here differ from those usually evoked by mechanical stimulation with a needle or human finger. These and other objects cause the animal to lower the shell and cease crawling. Similarly, response to being touched by other herbivores is weak, often causing retraction of a tentacle and a little or no retraction into the shell, but never flight. Carnivores likewise show little or no reaction to being touched by other carnivores.

Herbivorous gastropods found to be sensitive to touch stimuli from carnivorous gastropods are *Melagraphia aethiops*, *Zediloma digna* Finlay, *Z. arida* Finlay, *Z. atrovirens* (Phil.), *Trochus viridis* (Gm.), *Anisodiloma lugubris* (Gm.), *Haliotis iris* Martyn, *Cellana radians* (Gm.), and *C. ornata* (Dillwyn). The fissurellid *Scutus breviculus* (Blainville) and the turbinid *Lunella smaragda* (Martyn) show no response. This may perhaps be explained by the copious covering of mucus on the former, and the heavy calcareous operculum of the latter. The carnivorous gastropoda used as stimulators were *Lepsia haustrum*, *Lepsiella scobina* (Q. & G.), *Buccinulum strebeli* (Suter) and *Cominella maculosa* (Martyn). There appears to be no correlation between sensitivity to different

carnivores and position occupied on the shore by carnivores and herbivores. *Lunella smaragda* shows no reaction to *Cominella maculosa*, which lives in the same zone (about mean low water springs), while *Zediloma digna*, which is found at the level of mean high water springs, reacts violently to being touched by *C. maculosa*, which it must rarely, if ever, meet in Nature.

A single specimen of *Lepsia haustrum* was ground up in a pestle and mortar with ground glass and a few ml. of sea water. This was allowed to settle, the supernatant liquor drawn into a pipette, and a few drops placed on the side of the foot of *Melagraphia aethiops*. This evoked a weak reaction. A similar extract of *Mytilus planulatus* Lam. produced no visible results. This tends to support Bullock's view that the stimulus which evokes these reactions is chemical in nature.

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A Spurious Significance in Genecological Trials

Attention has been directed[1] to the fact that reduplication of individual genotypes in population sampling gives rise to spuriously low values of the standard error, and hence misleadingly high significance of difference between populations. This naturally leads one to wonder whether reduplicated genotypes are at all frequent in population samples. Further work on perennial plants of hill grazings has now suggested that the risk of reduplication is very high in some cases.

Detailed morphological examination of plants isolated from the wild has revealed numerous cases of strikingly similar isolates, and these are always from points relatively close together; isolates from greater distances apart never being so similar. In a few cases the separate isolates within a similar group have been cloned and laid out in a replicated trial, and it is found that they cannot be distinguished by any scored character: a block of twelve isolates each replicated ten times appears like a block of 120 ramets of a single plant. (In cases where an apparently similar yet distinct isolate has been included in a trial, that one can be picked out in every replication.) It is very tempting to regard such a group of similar isolates as being of a single genotype. Clearly such an assertion can never be proved, but the results of certain lines of investigation have no other simple interpretation. For example, it is found that virtually self-sterile isolates set no more seed on crossing with an apparently identical isolate than they do on selfing; yet they set seed freely when crossed with recognizably distinct isolates. If the interpretation is correct, then the experimental results give a clear impression of the extent and abundance of individual genotypes in natural communities, and an indication of the chances of genotype reduplication in sampling.

One genotype of *Festuca rubra* appears to have a spread of 250 yards, and over this range it is abundant, forming 70 per cent of the isolates from central parts falling to 3 per cent at one point on the margin: over some nine acres one-third of the tillers isolated belong to this one clone. At one part of the range a separate collection was made of nearly 1,500 tillers, isolated at 9-in. intervals from within a 10-yard square quadrat. Approximately 47 per cent of the tillers were referable to this one clone. Other 'large' cones accounted for 12, 6 and 4 per cent of the tillers respectively. A further 39 clones were isolated less than 25 times (1·7 per cent) each, while 105 isolates remained ungrouped and possibly represent genotypes isolated only once each. This clearly suggests a log distribution[2]. The second and the third largest clones, both of which were markedly localized within the quadrat, have not been found elsewhere. The fourth largest clone, however, which was scattered over the quadrat, has a total spread of at least 100 yards. If this picture of genotype distribution is typical of the species in general, then population sampling in *Festuca rubra* at a higher rate than one plant per acre is likely to lead to spurious significance.

In *Holcus mollis* (the pentaploid form) the picture appears to be slightly different in that only 'large' genotypes occur. In an area of 300 yards across only three genotypes seem to be present, each of them widespread and isolated many times. This suggests that new genotypes are not being established.

It appears the clones of *Festuca ovina* do not often exceed four yards in diameter. This comparatively meagre spread is in fact a surprising performance when one considers its growth habit: the age of such a clone is probably to be measured in hundreds of years. It seems likely that in this species spurious significance can be avoided by adopting a suitably restrained sampling technique. In fact, genotype reduplication might not occur to a serious extent in normal sampling procedure, and it may be instructive to reflect that in this species no difference has been found between populations from neighbouring but ecologically distinct sites[1].

The assumed age of some genotypes in all three species is not without its genecological interest. The most recent products of breeding and selection are apparently no more suited to the prevailing environment than their forebears of scores of generations back. Furthermore, the territories concerned are non-uniform and in spreading outwards single genotypes of both *F. rubra* and *H. mollis* have been able to enter, and compete successfully in, any habitat which does not actually exclude that species, suggesting that there is little genecological specialization present.

Finally, it should be pointed out that, since it is unlikely that any two seedlings are identical in genotype, one way of avoiding genotype reduplication is to raise population samples from seed. Unfortunately, however, this need not avoid spurious significance since the variance between the seed progeny of a single plant is almost certainly lower than that between plants of different parentage.

A complete account of this work is being prepared for publication elsewhere.

D. J. Harberd

Scottish Plant Breeding Station,
Pentlandfield,
Roslin, Midlothian.
Oct. 18.

[1] Harberd, D. J., *New Phytol.*, **56**, 269 (1957).
[2] Williams, C. B., *J. Ecol.*, **42**, 1 (1954).

FORTHCOMING EVENTS

Monday, January 13

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.15 p.m.—Monsieur M. Büchler: "Classification of the Population by Social and Economic Characteristics".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. I. J. Good: "Could a Machine Make Probability Judgments?"

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Use of Electricity in the Garden by Amateurs", opened by Mr. M. M. Harvey.

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.30 p.m.—Mr. Duncan Carse: "South Georgia Survey".

Tuesday, January 14

INSTITUTION OF THE RUBBER INDUSTRY, LONDON SECTION (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. F. N. B. Bennett: "Modern Testing Methods and Equipment"; 7 p.m.—Mr. W. S. Penn: "New Synthetic in Cables".

INSTITUTION OF MECHANICAL ENGINEERS, AUTOMOBILE DIVISION (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Dr. T. P. Hoar: "The Prevention of Corrosion in Car Bodies".

Wednesday, January 15

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Stanley Gooding: "Modern Research into Bees and Bee-Keeping".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at 47 Belgrave Square, London, S.W.1), at 6 p.m.—Dr. B. F. J. Schonland, F.R.S.: "Physical Research in the Research Group of the Atomic Energy Authority".

INSTITUTE OF METALS (at 17 Belgrave Square, London, W.C.1), at 6.30 p.m.—Dr. David Turnbull: "The Mechanism of Clustering and Precipitation in Metals".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the LONDON SECTION of the SOCIETY OF CHEMICAL INDUSTRY, at the College of Preceptors, 2 and 3 Bloomsbury Square, London, W.C.1), at 6.30 p.m.—Prof. W. E. Garner, F.R.S.: "Recent Advances in Catalysis".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. T. P. Hoar and Mr. J. G. Hines: "Stress Corrosion Cracking".

Thursday, January 16

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—General Meeting.

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. A. S. Besicovitch: "Sharpening some Lebesgue Theorems".

CHEMICAL SOCIETY (in the Large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 7.30 p.m.—Prof. D. H. R. Barton, F.R.S.: "Some Aspects of Sesquiterpenoid Chemistry" (Inaugural Simonsen Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 26 Portland Place, London, W.1), at 7.30 p.m.—Symposium on "Onchocerciasis".

Friday, January 17

ROYAL SOCIETY OF MEDICINE, EPIDEMIOLOGY and PREVENTIVE MEDICINE SECTIONS (at 1 Wimpole Street, London, W.1), at 5 p.m.—Symposium on "Weather and Disease".

INSTITUTE OF NAVIGATION (at 1 Kensington Gore, London, S.W.7), at 5.15 p.m.—Mr. J. R. Saxton: "The Influence of Atmospheric Conditions on Radar Performance".

Saturday, January 18

BRITISH PSYCHOLOGICAL SOCIETY (in the Psychology Department, Birkbeck College, Malet Street, London, W.C.1), at 2.30 p.m.—Dr. R. Melzack (University of Oregon Medical School): "Some Recent Experiments on the Problem of Pain".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST, Basic grade (with a science degree)—The Group Secretary, Doncaster Hospital Management Committee, Doncaster Royal Infirmary, Doncaster (January 18).

LECTURER IN ELECTRICAL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (January 18).

HEAD (well qualified graduate of a British university) OF THE ELECTRICAL ENGINEERING DEPARTMENT—The Clerk to the Governing Body, Battersea College of Technology, London, S.W.11 (January 20).

CHAIR OF BOTANY tenable at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 29).

LECTURER IN INORGANIC CHEMISTRY at the University of Canterbury, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, January 31).

LECTURER IN MATHEMATICS at the University College of Ghana—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (January 31).

LECTURER IN PHYSICS at the University of New England, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, January 31).

READER IN ORGANIC CHEMISTRY at King's College, Strand, London, W.C.2—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 1).

LECTURER IN CHEMISTRY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 8).

LECTURER (with a knowledge of mathematical statistics) IN PURE MATHEMATICS—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (February 8).

LECTURER (preferably with experience of virus work) IN BACTERIOLOGY; and a GEORGINA MCROBERT FELLOW, to investigate the cause, prevention and treatment of cancer—The Secretary, The University, Aberdeen (February 14).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN PHYSICS, CHEMISTRY, ENGINEERING, METALLURGY and PHARMACOLOGY or any related subjects—The Registrar, The University, Liverpool (February 15).

SENIOR LECTURER IN NUMERICAL ANALYSIS at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, February 15).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS (4) IN CHEMISTRY, PHYSICS, PHYSICAL CHEMISTRY, BIOCHEMISTRY, CHEMOTHERAPY, PHARMACOLOGY, PHARMACY, COLLOID SCIENCE, METALLURGY, ENGINEERING, GEOLOGY or AGRICULTURAL SCIENCE—The Registrar of the University of Wales, University Registry, Cathays Park, Cardiff (March 8).

TURNER AND NEWALL RESEARCH FELLOW IN ENGINEERING, INORGANIC CHEMISTRY or PHYSICS or other allied science—The Registrar, The University, Leeds 2 (April 12).

ASSISTANT LECTURER (Grade B) IN CHEMISTRY—The Principal, Royal Technical College, Salford 5.

ASSISTANT (man or woman, with a good reading knowledge of Russian) for abstracting scientific papers in economic entomology—The Director, Commonwealth Institute of Entomology, 56 Queen's Gate, London, S.W.7.

BACTERIOLOGIST (with the Ph.D. degree) to undertake research on the physiology and biochemical activities of bacteria and to supervise the maintenance of a culture collection—Dr. G. A. Ledingham, Director, Prairie Regional Laboratory, National Research Council, Saskatoon, Saskatchewan, Canada.

CHAIR OF PSYCHOLOGY—The Registrar, The University, Bristol.

ENTOMOLOGIST (with a good honours degree in an agricultural science and at least two years postgraduate experience in entomology) IN THE AGRICULTURAL DEPARTMENT, Sierra Leone, to organize control measures for insect pests of coffee, cocoa and other crops—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.63/15/011.

HISTOLOGICAL TECHNICIAN (preferably with the diploma of the I.M.L.T. in histology) IN THE DEPARTMENT OF MORBID ANATOMY—Dr. M. Bodian, Department of Morbid Anatomy, The Hospital for Sick Children, Great Ormond Street, London, W.C.1.

RESEARCH WORKER (with a degree in psychology)—The Director, Burden Institute, Stoke Lane, Stapleton, Bristol.

SCIENTIFIC OFFICER (CHEMIST) (with a first- or upper division second-class honours degree in chemistry of equivalent qualification, and preferably at least two years postgraduate experience in inorganic analysis and a specialized knowledge of silicate and/or spectrographic analysis) IN THE DEPARTMENT OF GEOLOGICAL SURVEY, Federation of Nigeria, for duties which include the analysis of rocks, ores and minerals in the Geological Survey Laboratories—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.105/14/09/T.

TECHNICIAN (Associate of the Institute of Medical Laboratory Technology) IN THE DEPARTMENT OF SURGERY, University of Oxford—Nuffield Professor of Surgery, Radcliffe Infirmary, Oxford.

TECHNICIAN (with the A.I.M.L.T. or equivalent qualification), for duties mainly consisting of assisting with research—The Secretary, Guy's Hospital Medical School, London Bridge, London, S.E.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Memoirs of the Geological Survey of Great Britain (England and Wales). Geology of the Country around Sheffield. By R. A. Eden, I. P. Stevenson, and Wilfrid Edwards. (One-inch Geological Sheet 100, New Series.) Pp. ix+238+6 plates. (London: H.M. Stationery Office, 1957.) 27s. 6d. net. [1110

Building Research Station Digest No. 102 (September, 1957): Miscellany—Window-sills; Bonding Agents; Staining and Efflorescence; Half-hour Fire Resistance; Sound Insulation of Partitions; Flue-less Heaters; From Limestone to Sandstone. Pp. 6. (London: H.M. Stationery Office, 1957.) 3d. [1110

Report of the West African Timber Borer Research Unit, 1953–55. Pp. 44+1 plate. (London: Crown Agents for Oversea Governments and Administrations, 1957.) 5s. [1110

National Association for Mental Health. Annual Report, 1956–1957. Pp. 39. (London: National Association for Mental Health, 1957.) [1110

Library Association Pamphlet No. 17: Microrecording in Libraries: a Review of Present Practice. By J. Burkett. Pp. 55. (London: Library Association, 1957.) 8s. 8d. (6s. 6d. to L.A. members). [1110

Air Ministry: Meteorological Office. British Rainfall 1955: Report on the Distribution of Rain in Space and Time over Great Britain and Northern Ireland during the year 1955 as recorded by about 5,000 Observers. (Ninety-fifth Annual Volume of the British Rainfall Organization.) Pp. iv+230. (M.O. 629.) (London: H.M. Stationery Office, 1957.) 25s. net. [1110

Research Defence Society. Conquest Pamphlet No. 3: The Research Defence Society. By W. Lane-Petter. Pp. 14. (London: Research Defence Society, 1957.) 6d. [1410

British Cast Iron Research Association. Thirty-sixth Annual Report for the year ending June 30th, 1957. Pp. 16+1 plate. (Birmingham: British Cast Iron Research Association, 1957.) [1410

Forestry Commission. Forest Records, No. 33: Provisional Yield Table for Western Hemlock in Great Britain. By W. R. Evans and J. M. Christie. Pp. 20. (London: H.M. Stationery Office, 1957.) 1s. 9d. net. [1510

At the Farmer's Service: a handy reference to the various services available to Farmers in England and Wales. Pp. ii+64. (London: Ministry of Agriculture, Fisheries and Food, 1957.) [1510

Other Countries

Library of Congress—Technical Information Division. The Air Pollution Bibliography, Vol. 1. By Jack R. Gibson, Wave E. Culver, and Mary E. Kurz. Pp. vii+150. (Compiled for the Public Health Service, U.S. Department of Health, Education and Welfare.) (Washington, D.C.: Library of Congress, Technical Information Division, 1957.) [1110

Proceedings of the United States National Museum. Vol. 107, No. 3379: *Rhynobrissus cuneus*, a New Echinoid from North Carolina. By C. Wythe Cooke. Pp. 9–12 (1 plate). Vol. 107, No. 3390: Formosan Cossonine Weevils of Bamboo (Coleoptera: Curculionidae: Cossoninae). By Elwood C. Zimmerman. Pp. 13–24. Vol. 107, No. 3382: A New Species of Calanopia (Copepoda: Calamoida) from the Caribbean Sea. By Thomas E. Bowman. Pp. 39–46. Title-Page and Index to Volume 104 (Nos. 3338–3348). Pp. iv+651–694. (Washington, D.C.: Government Printing Office, 1957.) [1110

Scrimshaw: Folk Art of the Whalers. By Walter K. Earle. Illustrations by Jane Davenport. Pp. 36 (8 plates). (Cold Spring Harbor, N.Y.: Whaling Museum Society, Inc., 1957.) [1110

Imperial College of Tropical Agriculture. A Report on Cacao Research, 1955–1956. Pp. 60. (St. Augustine, Trinidad and London: Imperial College of Tropical Agriculture, 1957.) 15s. [1110

World Health Organization. Technical Report Series. No. 125: Expert Committee on Insecticides—Seventh Report. Pp. 31. 1 Swiss franc; 1s. 9d.; 0.30 dollars. No. 128: The Public Health Laboratory Service: Fifth Report of the Expert Committee on Health Laboratory Methods. Pp. 49. 2 Swiss francs; 3s. 6d.; 0.60 dollars. *Chronicle of the World Health Organization*, Vol. 11, No. 8 (August, 1957): Challenge of Atomic Energy. (Special Number.) Pp. 233–266. 1 Swiss franc; 1s. 9d.; 0.30 dollars. (Geneva: World Health Organization; London: H.M. Stationery Office, 1957.) [1110

Canada: Department of Mines and Technical Surveys. Publications of the Dominion Observatory, Ottawa. Vol. 14: Bibliography of Seismology No. 19, Items 9382–9627 (January to June, 1956). By W. E. T. Smith. Pp. 413+442. (Ottawa: Queen's Printer, 1957.) 25 cents. [1110

United States Department of Commerce: Weather Bureau. Research Paper No. 40: Principal Tracks and Mean Frequencies of Cyclones and Anticyclones in the Northern Hemisphere. Pp. ii+60 (72 charts). (Washington, D.C.: Government Printing Office, 1957.) 1 dollar. [1110

Osaka University: Faculty of Science. Annual Report of Scientific Works, Vol. 5, 1957. Pp. ii+148. (Osaka: Faculty of Science, Osaka University, 1957.) [1410

Fauna and Flora, No. 6, 1955. Pp. 151. (An Official Publication of the Transvaal Provincial Government.) (Pretoria: Director of Nature Conservation, P.O. Box 383, 1956.) [1410

Académie Royale de Belgique. Classe des Sciences. Mémoires, Tome 30, Fascicule 4: Méthode de Détermination Directe des Représentations Irréductibles Associées aux Harmoniques et Combinaisons de Vibrations Moléculaires. Par Camille Duculot. Pp. 90. (Bruxelles: Académie Royale de Belgique, 1957.) 80 francs. [1410

Publications de l'Observatoire de Genève. Série M: Météorologie. Fascicule 31: Résumé Météorologique de l'Année 1956 pour Genève. Par J. Ruche. Pp. 13. (Genève: Observatoire de Genève, 1957.) [1410

Annual Report of the Trustees of the Museum of Applied Arts and Sciences, Sydney. Pp. 14. (Sydney: Museum of Applied Arts and Sciences, 1957.) [1410

Bulletin of the American Museum of Natural History. Vol. 113, Article 2: A Historical Review of the Mollusks of Linnaeus. Part 5: The Genus *Murex* of the Class Gastropoda. By Henry Dodge. Pp. 73–244. (New York: American Museum of Natural History, 1957.) 2.50 dollars. [1410

Harvard University: Blue Hill Meteorological Observatory. Meteorological Radar Studies. No. 4: Advection and the Melting Layer. By Raymond Wexler. Pp. 12. No. 5: Synoptic-Physical Implications of 1.25 cm. Vertical Beam Radar Echoes. By Roland J. Boucher. Pp. 24. No. 6: Moisture Supply and Growth of Stratiform Precipitation. By Raymond Wexler and David Atlas. Pp. 19. (Milton, Mass.: Blue Hill Meteorological Observatory, Harvard University, 1957.) [1410

Union Observatory, Johannesburg. Annual Report for 1956. Pp. 6. (Johannesburg: Union Observatory, 1957.) [1410

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 117, No. 1: A Study of the Sharks of the Suborder Squaloidea. By Henry B. Bigelow and William C. Schroeder. Pp. 150+4 plates. Vol. 117, No. 2: Check List of the Reptiles and Amphibians of East Africa (Uganda; Kenya; Tanganyika; Zanzibar). By Arthur Loveridge. Pp. 151–362+xxxvi. Vol. 117, No. 3: The Spider Genera *Crustulina* and *Steatoda* in North America, Central America, and the West Indies (Araneae, Theridiidae). By Herbert W. Levi. Pp. 363–424 (156 figures). (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1957.) [1410

United States Department of Agriculture. Index-Catalogue of Medical and Veterinary Zoology. Supplement 7, Authors A to Z. Pp. ii+1789–2139. (Washington, D.C.: Government Printing Office, 1957.) 1.25 dollars. [1410

Smithsonian Miscellaneous Collections. Vol. 134, No. 11: Anatomy and Taxonomy of the Mature Naiads of the Dragonfly Genus *Plathemis* (Family Libellulidae). By Harvey R. Levine. Pp. 28. (Washington, D.C.: Smithsonian Institution, 1957.) [1410

United States Department of the Interior: Geological Survey. Bulletin 1019-E: Magnesium Resources of the United States—a Geologic Summary and Annotated Bibliography to 1953. By Robert E. David. Pp. iv+373–515+plate 2. 70 cents. Bulletin 1019-H: Selected Annotated Bibliography of High-Grade Silica of the United States and Canada through December, 1954. By Marion C. Jaster. Pp. iii+609–673. 25 cents. Bulletin 1019-I: Annotated Bibliography of High-Calcium Limestone Deposits in the United States including Alaska, to April 1956. By G. C. Gazdik and Kathleen M. Tagg. Pp. iii+675–712. 20 cents. Bulletin 1036-K: Differential Thermal Analysis of Selected Borate Minerals. By Robert D. Allen. Pp. iii+193–208. 15 cents. Bulletin 1043-B: Application of High-Order Stereoscopic Plotting Instruments to Photogeologic Studies. By C. L. Pillmore. Pp. 34. 15 cents. Bulletin 1061-A: Pennsylvanian and Permian Rocks of the Southern Inyo Mountains, California. By Charles W. Merriam and Wayne E. Hall. Pp. iii+15. 15 cents. (Washington, D.C.: Government Printing Office, 1957.) [1410

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Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft, Berlin-Dahlem. Heft 90 (August, 1957): Über den Einfluss von Temperatur und Luftfeuchtigkeit auf den Eiparasiten *Trichogramma cacoeciae* Marchal (Eine biometrische Studie). Von Dr. Wolfgang Quednau. Pp. 63. 7 D.M. Heft 91 (September, 1957): Die blatt- und rindenbewohnenden Pilze der Pappel unter besonderer Berücksichtigung der Krankheitserreger. Von Dr. H. Butin. Pp. 64. 7 D.M. (Berlin-Dahlem: Biologischen Bundesanstalt für Land- und Forstwirtschaft, 1957.) [1510

Food and Agriculture Organization of the United Nations. FAO Nutritional Studies. No. 15: Calorie Requirements—Report of the Second Committee on Calorie Requirements. Pp. viii+68. (Rome: Food and Agriculture Organization of the United Nations; London: H.M. Stationery Office, 1957.) 3s. 9d.; 0.75 dollars. [1510

A History of Lake Rukwa and the Red Locust. By D. L. Gunn. Pp. 19. (Dar-es-Salaam: Tanganyika Notes and Records; Abercorn: International Red Locust Control Service, 1956.) [1510

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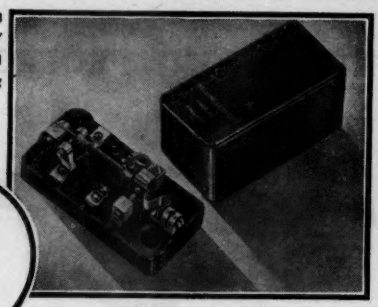

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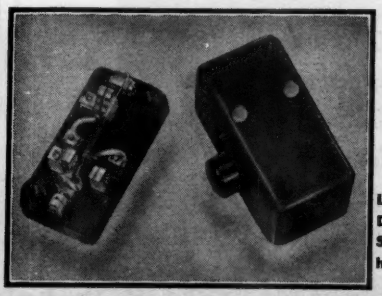

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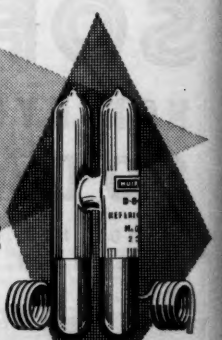

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Internal resistance at 25°C	Average 800 ohms maximum 1200 ohms
Temperature hysteresis	Negligible over normal operating range of temperature

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